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ABSTRACT

Described is a model which responds to the need for a systematic, conceptual framework for understanding energy. The specific vehicle for enhancing this understanding for the model is postsecondary adult vocational education. The model is intended to assist educators in designing and developing curricula tailored to the needs and interests of their own students. The document is divided into two parts. The first part is a resource book describing the key knowledge elements of the model and a bibliography of energy-related materials. The second part is an application guide designed to illustrate how elements of the model can be used in the instructional process. (RE)

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THE ENERGY CONSERVATION CURRICULUM MODEL

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SE 029 206

THE ENERGY CONSERVATION CURRICULUM MODEL

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April 1979

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PREFACE

This volume contains the four component documents of the Energy Conservation Curriculum Model. These four documents characterize and integrate, in a generic fashion, a comprehensive approach to energy conservation and its relationship to post-secondary vocational and adult education. The components of the Model have been designed to answer a series of questions. These documents and the questions around which each document was developed are the following:

- The Orientation Guide describes the rationale for energy conservation, elaborates upon the assumptions influencing Model design, and provides an overview of the remaining documents. The Guide addresses the question, "Why does the educator need to know about energy conservation?"
- The Curriculum Content Model provides a framework and an essential set of content areas relevant to developing an understanding of energy conservation. The Content Model addresses the question, "What does the educator need to know or to consider to develop a comprehensive understanding of energy conservation?"
- The Resource Book describes in additional detail the knowledge areas of the Curriculum Content Model and contains extensive bibliographies of references and information resources. The Resource Book addresses the question, "What learning materials and resources are useful in acquiring an understanding of energy conservation?"
- The Application Guide provides guidelines and examples of how the curriculum content could be infused into existing courses or used as a basis for new course development. The Guide addresses the question, "What types of instructional and learning arrangements could be used to transmit an understanding of energy conservation to students?"

The Model is intended to provide a generic conceptual base for staff development programs and materials in specialized occupational fields. This use is based on the belief that administrators and instructors must understand energy conservation and its relevance to their fields in order to develop and implement effective instructional programs for students. Although the ultimate target audiences are these administrators and instructors, and then their students, the documents in this volume are addressed mainly to curriculum and program designers who would develop, in cooperation with instructors and administrators, these more targeted and specific applications of the content and guidelines described in the Model.

The Energy Conservation Curriculum Model was sponsored by a grant from the United States Office of Education, Bureau of Occupational and Adult Education. A more complete description of the activities of this project can be found in the document "Environmental Quality and Energy Conservation Curriculum Model: Final Report."

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ORIENTATION
GUIDE

THE ENERGY CONSERVATION CURRICULUM MODEL

ORIENTATION GUIDE

A Perspective on Energy Education and Energy Conservation

The "energy crisis" sparked by the 1973 oil embargo may be seen as the "sputnik" of the '70's. Both events, for a different set of reasons, have greatly influenced large sectors of the American public. Nearly every facet of our lives, in fact, has been influenced in some way by the energy crisis and ensuing policy decisions made in response to it. As indicated in a recent national assessment of energy awareness among young adults,

> Americans have been forced to consider energy issues because of increasing costs and the sudden recognition that certain vital resources in our country are being severely depleted. Energy problems have obvious implications for government, for business and commerce and for foreign policy--but they impinge on individuals and their current life-styles as well.[1]

And, the solutions for these energy problems are seen to depend heavily on the knowledge and attitudes of an informed citizenry.[2] Since the energy crisis, leaders in both the formal and non-formal education sectors have attempted to articulate their role and responsibility relative to creating an informed public. The major response has been the development of curriculum and instructional materials in what is generally called "energy education." Although the objectives and activities of the various energy education programs vary, as Donald Duggan of the Department of Energy's Educational Division has said, "the scope of energy education is to educate our future citizens to make the very difficult decisions that they will make as citizens, voters, and consumers."[3]

Within the context of energy education, energy conservation should be an important and fundamental topic. It is sometimes thought that energy conservation education involves training people to save energy through various changes in behavior like insulating homes, lowering the thermostat, etc.

These outcomes, while important, are energy conservation only in its very narrowest sense. In a much broader sense, energy conservation requires that we understand how much energy we are using and also how wisely and appropriately we are using it. The criterion for appropriateness involves considerations of environmental quality and the quality of human lives. In this broader context, it is difficult to distinguish between energy education and energy conservation education. Both involve discussions of many of the same topics and both are oriented toward enabling persons to make individual and collective decisions that will help remedy energy problems.

Energy Conservation in the Context of Vocational Education

Within the field of vocational education considerable attention has been placed of late on energy topics, particularly the role of vocational education in solving the energy dilemma. A review of the literature written by vocational educators reveals two areas of responsibility, and a third is less clearly articulated.

The first and most obvious responsiblity of vocational education is to train workers in fields related to current and future energy technologies. In a special 1977 report to the President of the United States on the role of vocational education in the energy crisis, the National Advisory Council on Vocational Education outlined this responsibility in the following manner.

> Now is the time for vocational education to begin to prepare for the emerging technologies and industries of the 1980's. The preparation which is demanded from the vocational education leadership lies primarily in the area of curriculum development....In addition, all vocational education counselors and instructors in the energy technology and industry occupations must begin to acquire at least a minimum background of alternative energy sources and energy delivery systems. All must be prepared also to respond in a positive way to the necessity for diminishing the demand for energy.[4]

Moving from this global statement to a more specific definition of vocational education's role, one finds recommendations such as:

> In the middle grades, industrial arts programs can provide the awareness and orientation to the energy problem and alternative sources. In the senior high school, vocational trade programs can prepare installers and assemblers. At the post secondary level, technicians can be trained. In all schools energy education must take its place as a curriculum imperative.[5]

A series of recent articles in VocEd, the journal of the American Vocational Association, outlined a second role for vocational education.[6] The authors of many of these articles suggested that energy concepts, techniques, and skills should be incorporated or integrated into existing occupational programs that have potential for addressing the energy situation in some relevant way. Fields such as agriculture, automotive mechanics, home economics, and the building trades are suggested as fruitful areas for the inclusion of new energy knowledge. For example, concepts and techniques related to insulation, weatherproofing, and efficient building techniques can be integrated into construction trade curricula. One possible result of this may be the energy conservation technician: a person who is competent in the established skills required for existing occupational areas, but who is also competent in assessing and developing techniques to better use energy.

Finally, there is a third area in which vocational education can assume a responsibility in dealing with our energy problems. This role has not been expressed clearly by vocational educators themselves but can be inferred from what has been suggested as necessary for solving the energy dilemma. The suggestion is that all workers, whether or not they are directly involved in energy technologies or energy-related fields, need to possess an energy ethic. They should be able to understand the importance of energy use and its relationship to their respective occupations, as well as to their personal lives.

As Ione Phillips, editor of VocEd has said, "...no field of vocational education can afford to stand back and say, 'the nation's energy problem is of no concern to us.'"[7]

This is a more subtle but more fundamental responsibility of vocational education. It implies that our nation's energy problems will not be solved by energy technicians or specialists alone. We will need citizen-workers who possess not only the usual competencies to be successful in their respective fields but also an expanded awareness which includes an energy ethic. Knowledge about energy conservation in its broadest sense can contribute to the development of this energy ethic.

Current Energy-Related Activities of Vocational Education

Given that these three areas represent major responsibilities of vocational education in dealing with our energy problems, what has happened in the vocational and technical education arena relative to the development of energy-focused programs and curricula? What, for example, have been the major curriculum development efforts? There have been a number of surveys and studies that have attempted to assess the status of energy education at the post-secondary vocational as well as adult education level.

In an informal survey conducted at Far West Laboratory in 1977, at the beginning of this project to develop an energy conservation curriculum model, we attempted to compile documents which reflected vocational and adult education plans with respect to energy education in each state. From the materials returned, it was obvious that the majority of states recognize the need for and importance of energy education, but there were few comprehensive plans at the state level for implementing an energy-related curricula. State vocational and post-secondary adult educators, for the most part, did not have state plans or blueprints for what should be done, but could point to individual efforts that were functioning well or in the planning stages. These efforts were primarily to train technicians in energy-related areas like weatherization, water treatment, solar and coal technology. Few of these plans specified what competencies the technicians should possess.

A more recent and comprehensive survey assessing current offerings throughout the country of energy-related training activities was conducted for the Department of Health, Education and Welfare. Data were compiled relative to the following twelve energy-related areas: audits, awareness, conservation, management, nuclear, petroleum, solar, coal, geothermal, ecology, wind, and biomass.[8] The survey thus provides a profile of energy-related courses, training programs, seminars, degrees, etc., offered by government agencies, private consultants, businesses, and at public and private two-year post-secondary educational institutions. From these data, compiled according to states, it is evident that most institutions have concentrated their efforts in the development of courses and training programs in the area of solar energy. Secondary areas of effort were in the fields of coal and petroleum technologies. The offerings in the areas of geothermal, wind, and biomass appear neglected, and the absence of activity in the nuclear area seems related more to the source of the survey data (two-year post-secondary institutions) rather than to the number of existent programs.

Noticeably absent from this assessment are offerings from institutions in both energy awareness or conservation and energy-related technologies. When the topics of energy awareness or conservation are covered, they usually appear as part of the general community college curriculum rather than in vocational technical programs. Thus, it is possible that the technical programs can be training technically competent workers in areas that are important for solving our energy problem, but who are not necessarily citizen-workers with an understanding of appropriate energy-use concepts. It is conceivable, for example, that we might be training solar energy technicians who carry out their job in an energy inefficient fashion or who cannot apply their energy understanding to their own personal lives.

Another study contributes a different perspective to this present inquiry into how educators, vocational and technical in particular, have responded to the "energy crisis."[9] The study examined post-secondary energy and power programs throughout the United States, looking at course topics or content, textbooks, and classroom materials presently offered by educational manufacturers and distributors. Table 1 presents the results of this study.

Table 1

	INFORMATION SOURCE		
CONTENT AREA	Colleges	Textbooks	Educational Materials
INTRODUCTION			
Conservation	10	14	0
Energy Policy	6	14	0
History and Future	10	20	0
SOLAR			
Thermal	10	11	2
Photovoltaic	5	10	2
Wind	11	10	2
ELECTRICAL			
Transmission	8	11	4
Generation	12	12	4
FUELS			
Fossil	11	19	3
Nuclear	10	20	1
Wood	2	4	2
Methane	7	10	2
Hydrogen	8	12	2
Geothermal	7	11	2
WATER SOURCES			
Hydroelectric	11	11	1
Tidal	4	8	1
Sea Thermal	4	9	0
CONVERTERS			
Steam	10	9	2
Internal Combustion	12	4	4
Fluid	12	3	4
Air	6	3	2

From "Post-Secondary Energy and Power Curriculum Study" by Stanley Primak and Rodney Anderson, Energy and Power Journal, 2, 1978, 10-16.

Two interesting results emerge from this study. First, the topic of conservation appears under the "Introduction" heading and does not appear to be integrated in any other manner into the remaining subject headings. This gives the appearance at least that one can examine, for instance, the topic of electrical energy separate from discussions about conservation. In reality we do not know how these topics are presented in relation to a particular set of program objectives; the results suggest, however, that conservation may be an optional topic in many energy-related curricula. The second interesting result is the complete lack of educational materials from commercial publishers dealing with the conservation content area.

One final study is of interest. Although the purpose of the study was to survey precollege energy education curricula, the results are worth noting. This survey, conducted by the Energy Institute of the University of Houston, reached the following conclusions:[10]

(1) Energy education materials tend to stress technical topics.

(2) They do not adequately stress policy issues and the political and economic milieu in which controversial policy issues are resolved.

(3) They often lack consistent core themes and adequate conceptual frameworks.

(4) They provide little that is useful in the development of an alternative energy ethic.

Based on these studies, then, we can make some tentative generalizations about the responses of educators, post-secondary and vocational in particular, to the energy "crisis" situation.

(1) There are few comprehensive plans at the state level to guide the systematic development and implementation of energy-related curriculum offerings into post-secondary adult and vocational programs. Existing programs seem to be the result of individual and somewhat isolated efforts rather than in response to imperatives or recommendations from the educational or governmental sectors.

(2) An increasing number of post-secondary institutions are becoming involved in providing solar training programs as solar energy becomes "big business." Plans are being made to develop training programs in other energy (conventional as well as alternative) technical fields. There is an uncertainty, however, concerning the demand for jobs in these fields and the competencies which will be required.

(3) The emerging programs tend to stress technical topics and do not necessarily address or incorporate aspects of energy awareness or the acknowledged necessity for the development of an energy aware literate citizenry.

Given these results, it would seem that post-secondary vocational education as a whole is making a strong effort to meet the need for competent workers in both conventional and alternative energy fields. It is less clear whether efforts are being made to incorporate technical skills training related to efficient energy use in fields such as agriculture and the building trades. It is even less clear that these programs are addressing the need for all to be energy literate citizen-workers.

Governmental agencies, as well as various educational institutions, have recognized this need for more and better energy programs and materials and have attempted to address this need through teacher training. Within the last few years, many institutions have sponsored workshops for educational personnel. For example, the Department of Energy, working mainly with educational institutions, sponsored 68 faculty development workshops during the summer of 1978, with emphasis placed upon increasing understanding of energy issues and options. Most of these were specially targeted for post-secondary vocational personnel. In addition, numerous regional and national conferences are being held on energy-related topics.

What seems to be missing in efforts such as these is an intent to provide educational personnel with not only information and data about energy, but also a conceptual framework or structure within which to put such information. There appear to be few attempts to develop a framework based on a conception of what constitutes a comprehensive understanding of energy, particularly as it leads to the wise and effective use of energy resources or energy conservation. This lack of a conceptual framework has an important consequence for educators desiring to provide course offerings that go beyond basic energy "facts," and which lead to the adoption of an energy ethic or awareness. To expand into such areas requires, first of all, that educators themselves understand the conceptual structure of the subject matter per se. This means that educators must understand the essential concepts and principles of energy and have a framework for relating this knowledge to the wise and effective use of energy resources. Without such a prior conceptual understanding, it is difficult to select materials and learning resources which insure that students will be exposed to instructional situations that lead not only to a technical understanding of energy or the development of an energy-related technical skill, but also, more importantly, to the development of a basic energy literacy.

Purpose of the Energy Conservation Curriculum Model

The purpose of the Energy Conservation Curriculum Model described in the remainder of this document was to respond to this need for a systemic, conceptual framework for understanding energy, particularly focused on those elements that lead to a broad-based understanding of energy conservation. The development of these Model documents was the outcome of a project sponsored by a grant from the United States Bureau of Occupational and Adult Education. The specific goal of the project was to design a curriculum model for use by post-secondary adult and vocational educators in the area of energy conservation and environmental quality. In designing the Model an emphasis was placed on developing a conceptual framework and specifying content areas which should enable educators to understand these issues in a systemic manner. Based on this understanding of the essential or key aspects, educators can design and develop curricula and instructional materials tailor-made for the needs and interests of their students.

The project focused on energy conservation for several reasons. First of all, in this decade energy has been and continues to be an important and challenging issue. Second, as has been pointed out, "the extraction, conversion, and application of energy have been dominant ingredients of industrial society's assaults on the environment; to understand the environmental impact of energy is to grasp much of the environmental predicament as a whole."[11] Thus, the Curriculum Model itself has been imbedded within a context of energy's impact on the environment as well as in the context of human needs.

In addition to the ideas about what constitutes the appropriate roles of vocational and adult educators in dealing with our energy problem, the Curriculum Model documents were based on the following assumptions:

- There are many informative materials, films, pamphlets, etc., available to educators on energy-related topics. Often these are free or available at low cost from organizations like governmental agencies, utilities and citizens groups.
- There are few teacher training materials to assist educators in understanding the essential and generic concepts and principles necessary for exploring energy issues in a systematic manner.
- Whenever possible, these concepts and principles should be integrated or infused into existing curricula rather than taught as a separate course.

- Educators need to have a conceptual understanding of energy conservation in order to design and adapt their own curricula or instructional materials and to assess and use available materials most effectively.
- The best groups to develop or adapt materials are the teachers or instructors themselves.[12] What is important is to insure that they have a sound conceptual base from which to start.

The Curriculum Model Documents

The Energy Conservation Curriculum Model is described in a series of four documents. The first document in the series is this Orientation Guide. The Guide is designed to provide a context for energy conservation within vocational education, to elaborate on the assumptions that influenced the design of the Model, and to provide an overview of the remaining documents and their uses. The remaining documents are the Curriculum Content Model, the Resource Book, and the Application Guide.

The Curriculum Content Model presents an essential set of concepts and principles important for gaining a comprehensive understanding of issues related to energy conservation. These are presented in the form of a visual map, which identifies and locates these essential elements. Environmental quality topics are an important part of this map, as are issues that relate to the quality of human life. Because the model is intended for use by vocational educators, these human quality aspects specifically focus on current and future job opportunities.

The purpose of the Curriculum Content Model is to provide a conceptual orientation and approach for users as they explore additional resources (such as those identified in the Resource Book), assess currently available energy-related materials, or develop their own materials. The Curriculum Content

Model, in serving as a conceptual map and orientation, is not designed necessarily as a curriculum outline to be taught to students. Rather it is intended to be internalized by the instructors and to act as an organizer that will enable instructors to explore energy issues and materials in a systemic fashion.

The Resource Book contains two parts. The first part presents an elaboration of the key knowledge elements specified in the Curriculum Content Model. A section is devoted to each of the six sectors in the Content Model. Included in each section are references for further study related to the particular topics discussed. This manner of presentation supports the ultimate purpose of the Resource Book and Curriculum Model, which is to provide a comprehensive context for the use of readily available materials rather than serve as an exhaustive examination of particular topics.

Part two of the Resource Book provides a more complete bibliography of energy-related materials. Included in this bibliography are listings of films, career information materials, and periodicals. In developing this list, emphasis was placed on including information resources that would have a multiplier effect and lead the user to even more relevant materials.

The Application Guide is designed to illustrate how the preceding elements in the Model can be used in the instructional process. A general strategy for integrating energy conservation into the existing curriculum is presented. The remainder of the document provides several sample curricula and sets of suggested activities. It is important to note, however, that these outlines and activities are provided as application illustrations to provide an impetus for additional thinking and are not intended to be prescriptive.

It would be most helpful to review the remaining documents in the order in which they are presented. In this way, the reader will be able to build upon the approach or information presented in the previous document and, thus, will obtain a comprehensive understanding, in general terms, of energy conservation and its potential applicability to post-secondary vocational and adult education.

FOOTNOTES

1. National Assessment of Educational Progress, Energy Knowledge and Attitudes (Denver: National Assessment of Educational Progress, 1978), p. xi.

2. The proposed solutions to the 1979 version of the U.S. energy crisis are an example of this dependence on informed citizen support.

3. Donald Duggan, as quoted in Lillian A. Clinard, "Conservation--We Have Met The Enemy," VocEd, 54,1 (January, 1979), pp. 35-37.

4. National Advisory Council on Vocational Education, The Response of Vocational Education to the Energy Crisis (Washington, D.C.: National Advisory Council on Vocational Education, December, 1977).

5. Ralph V. Steeb, "Editorial," Energy and Power Journal, 2,5 (September, 1978), p. 2 (emphasis added).

6. See entire issue of VocEd, 54,1 (January, 1979).

7. Ione Phillips, "Editorial," VocEd, 54,1 (January, 1979), p. 27.

8. Daniel M. Hull, Curriculum for Energy Use- and- Conservation Technicians (Waco, TX: Technical Education Research Centers, Southwest Centers, 1979). Report No. 78-63-02B prepared for the U.S. Department of Health, Education, and Welfare.

9. Stanley Primak and Rodney Anderson, "Post-Secondary Energy and Power Curriculum Study," Energy and Power Journal, 2,5 (September, 1978), pp. 10-16.

10. Robert M. Jones and John E. Steinbrink, A Survey of Precollege Energy Education Curricula at the State Level (Houston, TX: Energy Institute, University of Houston, June, 1977), p. 8.

11. Paul R. Ehrlich, Anne H. Ehrlich, and John P. Holdren, Ecoscience: Population, Resources, Environment (San Francisco: W.H. Freeman, 1977), p. 389.

12. John M. Fowler and King Kryger, "Emergency Vocational Instruction," VocEd, 54,1 (January, 1979), pp. 41-43.

CURRICULUM
CONTENT
MODEL

THE ENERGY CONSERVATION CURRICULUM MODEL

THE CURRICULUM CONTENT MODEL

Purpose

The purpose of the Curriculum Content Model is to provide educators who are interested in expanding their knowledge and awareness with a conceptual framework which will enable them to understand and analyze concepts relevant to energy conservation and environmental quality. We have chosen to call this framework a curriculum content model because the framework provides a structure for organizing and selecting energy content as well as the specification of key concepts and relationships. As such, this model is a map of energy conservation content. It is intended that once such a framework is internalized, educators will have the knowledge competencies with respect to energy conservation that will enable them to develop new curricula or change their current programs in a systemic manner, tailor-made to the needs of their students or geographical region.

Conceptual Base for the Curriculum Content Model

The Curriculum Content Model that is described in the next section is based on a particular approach to the specification of content on environmentally related topics.* The purpose of this approach is to ensure identification of all key concepts and relationships important to gaining a conprehensive understanding of an environmentally related topic. The basic notion behind this approach revolves around the fact that our human system and all of its activities are contained or "nested" within the natural system. Conflicts and problems occur when either system upsets the balance or health of the other. Most frequently environmental problems occur when human system activities, for example, oil spills or land abuse, upset the balance of the natural system. Hence, to understand and to prevent these conflicts, we must understand not only the activities of the human system and the natural system, but must also examine the interactions between the two. Such an approach may be graphically portrayed as displayed below with the human and natural system influencing each other.

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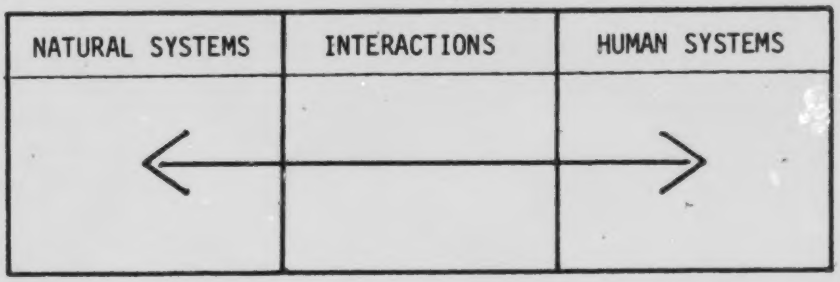
*For a description of this approach see section, "The User Strategy," in The High School Environmental Education Teacher Training Model: Content Sourcebook by Bela Banathy and others, (San Francisco: Far West Laboratory for Educational Research and Development, 1978).

Figure 1

HUMAN/NATURAL SYSTEMS INTERACTION MODEL



A further distinction is made within this framework relative to the conceptual and operational aspects of human/natural system interactions. This distinction is made in order to explore not only observable or "real world" phenomena (the operational level), but also the way we think about or analyze these events (the conceptual level). As we know, our problems often stem from the way we think about these phenomena, so it is critical that we are aware of and examine these aspects. Thus the framework now takes on the following form.

Figure 2

CONCEPTUAL FRAMEWORK FOR THE CURRICULUM CONTENT MODEL

	NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS	
OPERATIONAL				OPERATIONAL
CONCEPTUAL				CONCEPTUAL

This framework, representing a comprehensive approach to environmental issues, is relevant to energy conservation in that our goal in dealing with our energy problems and in implementing energy conservation measures must be to preserve a harmonious balance between the human and natural systems. As represented in the Model, energy conservation involves much more than the simple reduction of energy wastes. It implies the appropriate and wise use of energy resources in ways that minimize both short- and long-term negative impacts on the natural system and at the same time promote the equitable satisfaction of human needs. Thus, to truly understand energy conservation, we must examine key concepts in all sectors of the curriculum content framework and the relationships between these sectors.

With this goal, using the framework presented in Figure 2, we then have a basis for selecting and organizing content or subject matter with respect to energy conservation. The following figure illustrates the generic themes which have been specified for each of the sectors.

Figure 3

THEMES OF THE ENERGY CONSERVATION CURRICULUM CONTENT MODEL

	NATURAL SYSTEMS	INTERACTIONS	HUMAN SYSTEMS	
OPERATIONAL	resources (a)	technologies (b)	human needs (c)	OPERATIONAL
CONCEPTUAL	laws and functions (d)	energy utilization concepts (e)	values and the future (world views) (f)	CONCEPTUAL

As outlined in the various sectors of Figure 3, at the operational level, to develop a comprehensive understanding of energy conservation, we must examine (a) how human needs are satisfied (b) by using a variety of technologies to produce and use energy (c) from natural system resources. At the conceptual level, how we approach energy conservation depends upon (f) our values for the present and future (worldviews) and our understanding (e) of energy utilization concepts and (d) the laws and functions of ecosystems.

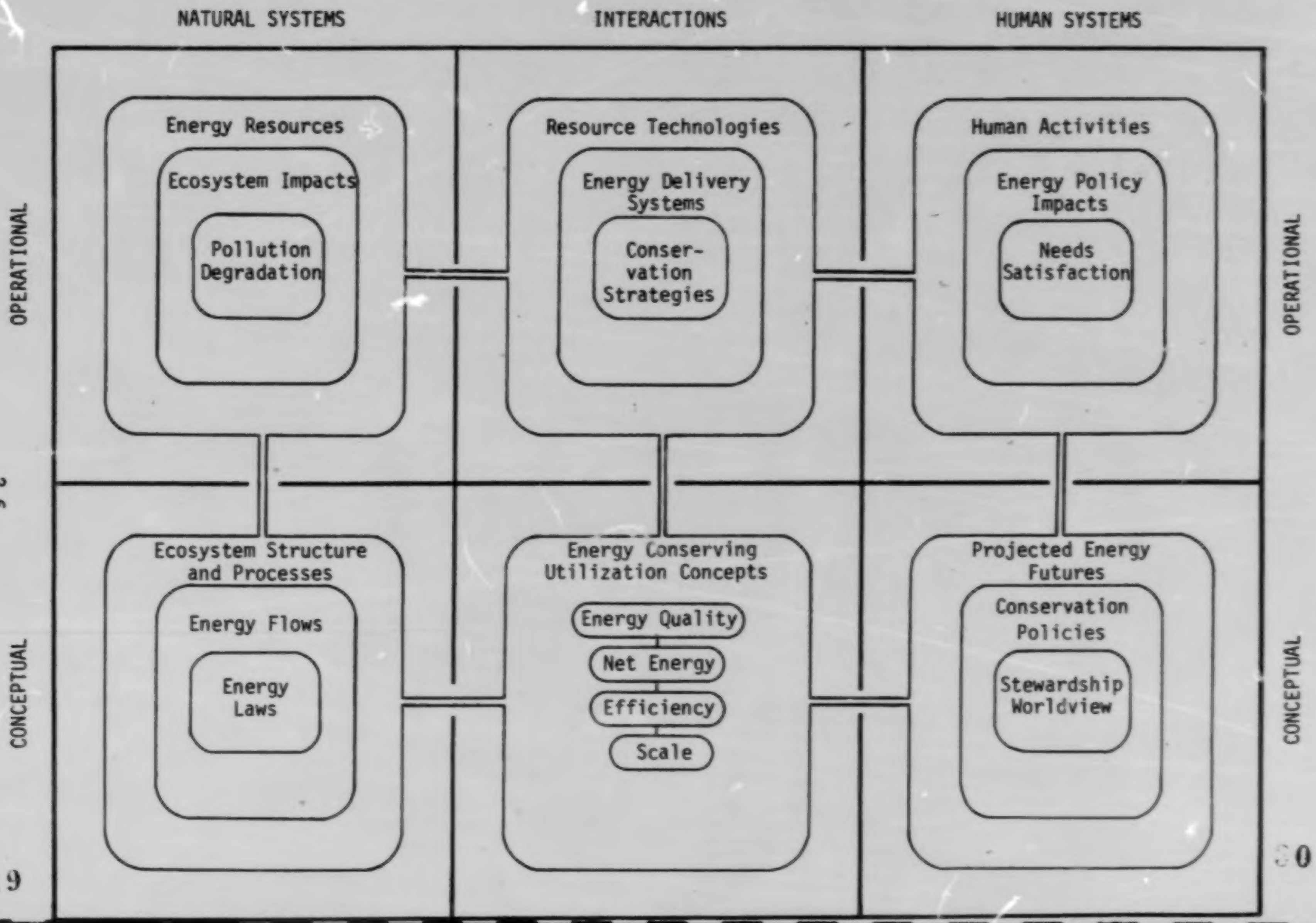
The Energy Conservation Curriculum Content Model

Figure 4 on the following page is a more complete visual presentation or map of all six sectors in the Energy Conservation Curriculum Model. As can be seen, additional detail has been added in each sectors of the model. This detail reflects, to a degree, the manner in which the content has been further focused in the Energy Conservation Curriculum Model Resource Book. The Resource Book contains an elaborated discussion of the knowledge components of the Content Model.

A more detailed description of each of the six sectors follows the presentation of the complete map of the Content Model. Where one enters the map is to a certain degree arbitrary. The content of all six sectors and the relationships between these sectors must be considered, however, to gain a comprehensive understanding of energy conservation.

FIGURE 4

The Energy Conservation Curriculum Content Model Map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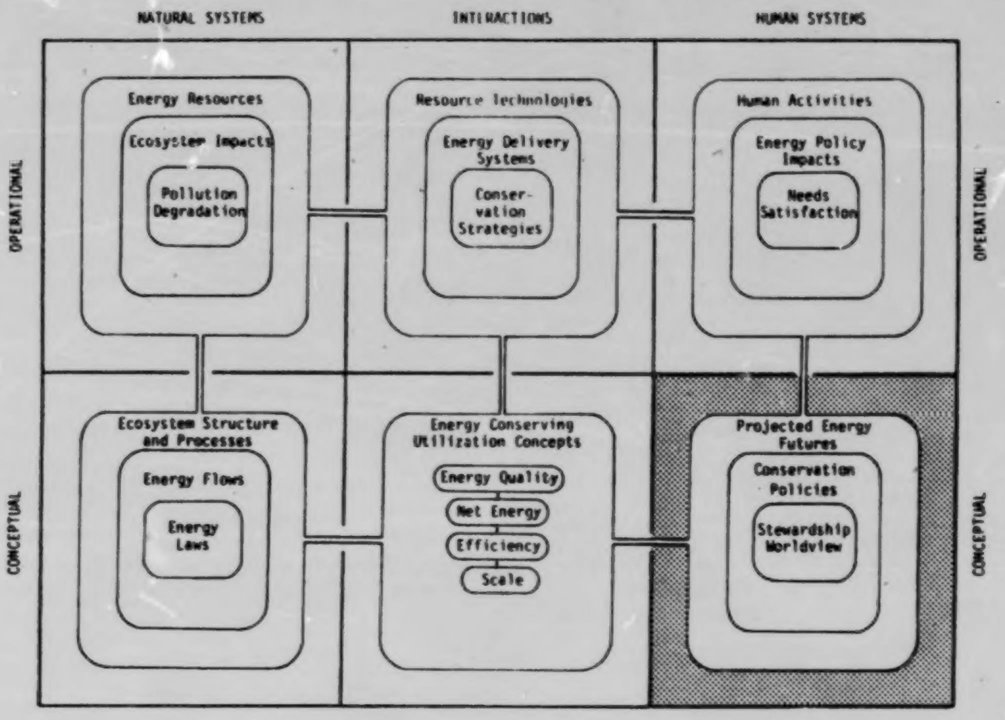
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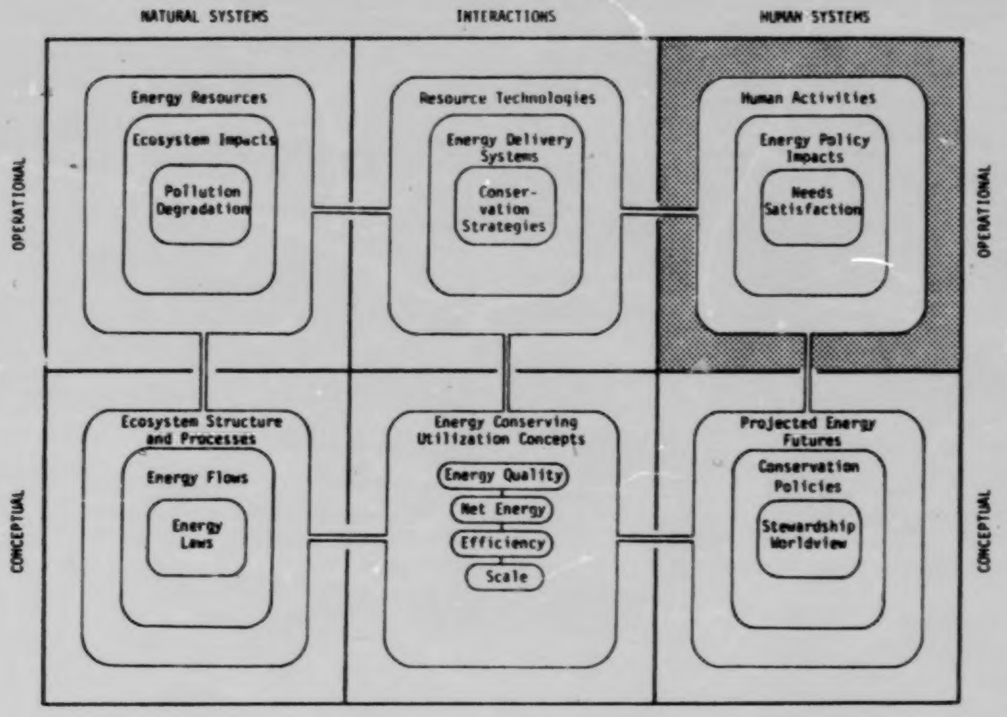
The Energy Conservation Curriculum Content Model Map

Human Systems: Conceptual Sector

This sector explores the choices we have with respect to our future. At the present time a variety of energy futures are being projected for us. We must examine the characteristics of these futures and their underlying values and beliefs to see if they describe worlds in which we wish to live. Then we must be anticipative to bring about a future we desire. From a conservation standpoint, various futures can be analyzed through an ethic called a stewardship worldview. This worldview implies that we have an obligation to make the world a more humane place for current and future generations.

The content of this sector is more fully described in the "Energy and the Future: A Stewardship Worldview" section of the Resource Book. The discussion there covers the following topics:

A. Projected Views of the Future
B. Energy Conservation in Future Design
C. A Conservation Ethic: A Stewardship Worldview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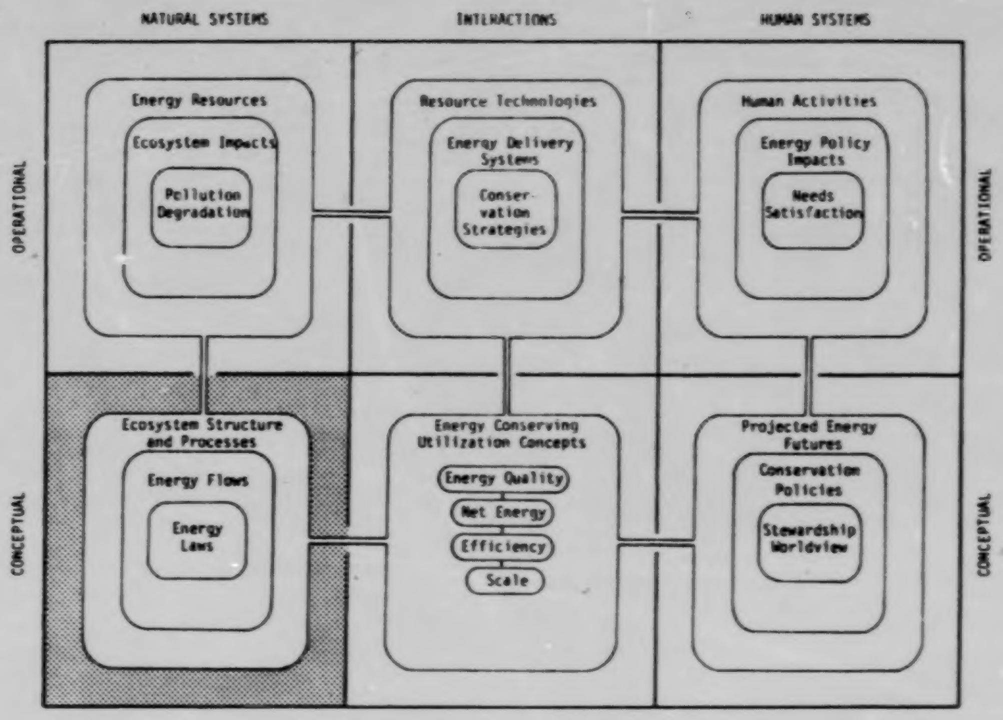
The Energy Conservation Curriculum Content Model Map

Human Systems: Operational Sector

This sector focuses on the relationships between energy and the activities of the human system. At the individual and collective level, most of these activities are related to the satisfaction of human needs. To make intelligent choices for the future, we must examine the interrelationships between energy policies and factors associated with a high quality of life such as adequate health care, transportation, shelter, etc. All of these human concerns are included in this sector; however, because the Curriculum Model is targeted for post-secondary adult and vocational education, the content focuses on energy, economic, and job relationships. Energy conservation has the potential to affect both the quantity and quality of all job opportunities. Likewise, all workers can contribute to the better use of energy.

The content of this sector is more fully described in the "Human Systems Needs: Jobs and Energy Conservation" section of the Resource Book. The discussion there covers the following topics:

A. Energy, GNP, and Economic Growth
B. Energy Intensities and Jobs
C. Energy Conservation and Job Opportunities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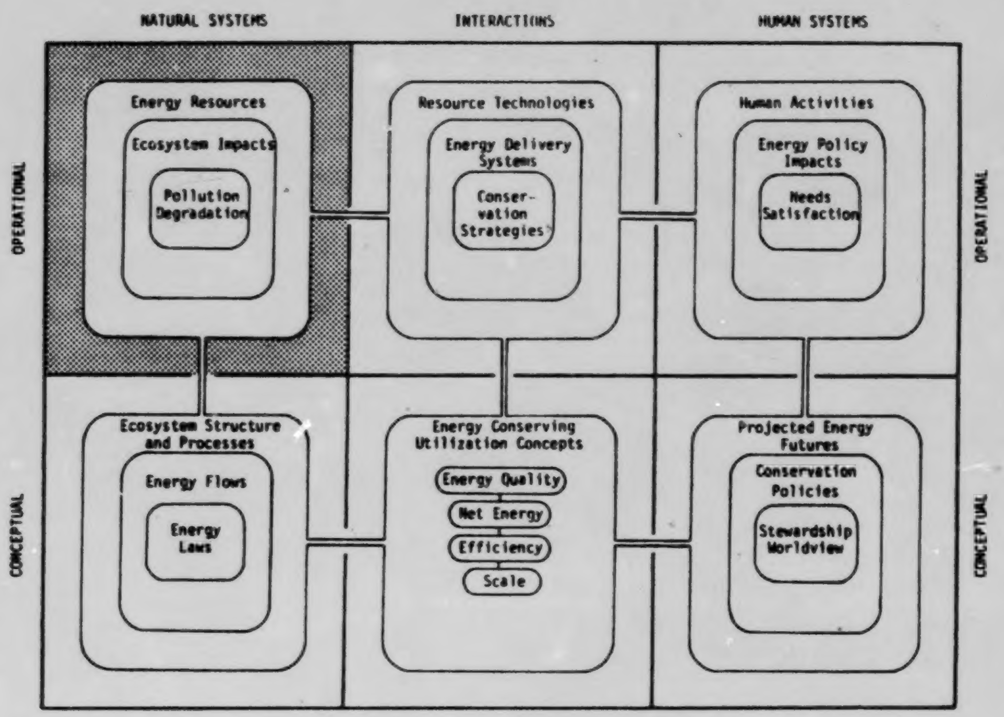
The Energy Conservation Curriculum Content Model Map

Natural Systems: Conceptual Sector

This sector focuses on the structure and functioning of the natural system and its component ecosystems. The natural system is the ultimate origin of all energy resources. Energy flows through these systems as they strive to maintain a dynamic equilibrium often referred to as ecological balance. The laws of thermodynamics and the necessity for maintaining ecological balance provide the initial fundamental conceptual bases for understanding the significance of energy conservation.

The content of this sector is more fully described in the "Energy and the Natural System" section of the Resource Book. The discussion there covers the following topics:

A. Ecosystems and Equilibrium
B. Laws Governing Energy Flows
C. Analysis of Energy Flows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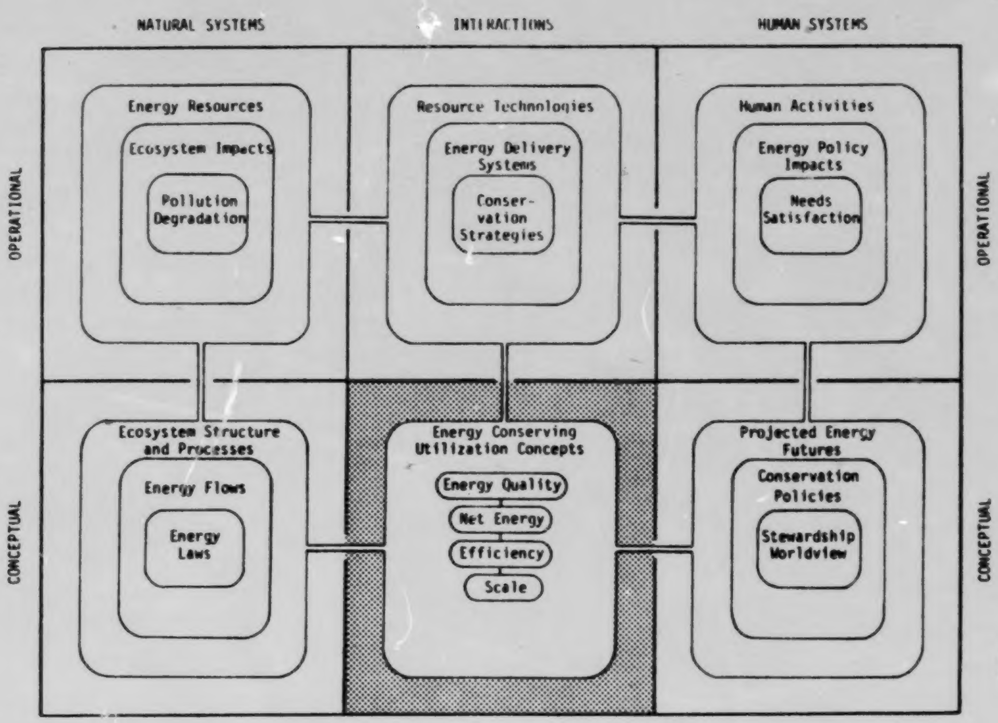
The Energy Conservation Curriculum Content Model Map

Natural Systems: Operational Sector

This sector explores the various forms of the renewable and non-renewable energy resources. The conversion of any energy resource into a useable form of energy affects environmental quality. Two general types of effects on the natural system are pollution and environmental degradation. These, of course, also have important implications for the quality of life. From a stewardship worldview, the goal of energy conservation strategies must be to nurture the natural environment. Greater energy savings are possible if we minimize negative impacts rather than trying to correct environmental assaults after they occur.

The content of this sector is more fully described in the "Natural System Energy Resources" section of the Resource Book. The discussion there covers the following topics:

A. Energy Resources: Non-Renewable
B. Energy Resources: Renewable
C. Effects of Energy Utilization on the Natural System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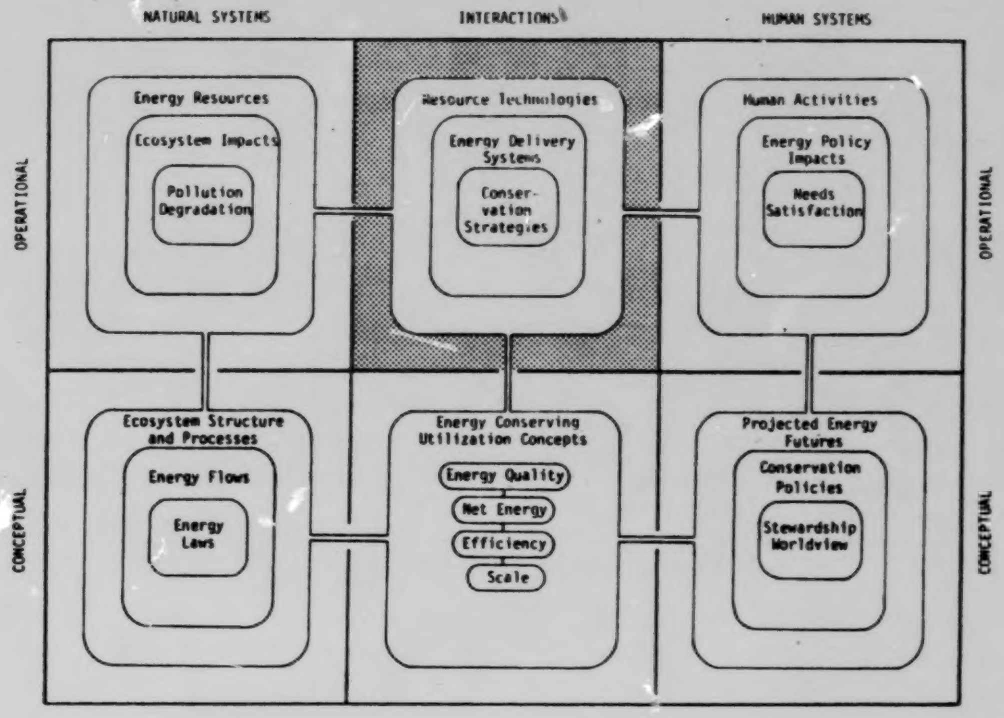
The Energy Conservation Curriculum Content Model Map

Natural/Human Systems Interaction: Conceptual Sector

This sector focuses on concepts relevant to assessing the conservation potential of energy producing and utilizing technologies. Among these concepts are the energy quality, net energy, efficiency, and scale. These concepts are also useful in assessing the appropriateness of our technologies to meet our end use needs.

The content of this sector is more fully described in the "Energy Conserving Utilization Concepts" section of the Resource Book. The discussion there covers the following topics:

A. Energy Quality and End Use
B. Net Energy
C. Efficiency
D. Scale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The Energy Conservation Curriculum Content Model Map

Human/Natural Systems Interaction: Operational Sector

This sector describes a systematic framework for understanding energy technologies from their exploration to end use. These energy technologies, providing the basis for the interaction between human and natural systems, can be systematically compared through a detailed specification of the delivery system associated with each of the various energy resources. The energy components of all technologies can be examined systemically using a similar framework. Specific conservation strategies can then be developed based on this analysis of the total system.

The content of this sector is more fully described in the "Energy Delivery Systems" section of the Resource Book. The discussion there covers the following topics:

A. The Stages in Energy Delivery Systems
B. Energy Conservation Strategies

RESOURCE
BOOK

THE
ENERGY
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MODEL

RESOURCE BOOK

INTRODUCTION

The Energy Conservation Curriculum Model Resource Book is composed of two parts. Part One contains a more detailed discussion of the major knowledge or content components within each of the six sections of the Curriculum Content Model presented in the previous document. The presentation is based on the premise that through adopting an energy conservation ethic and by more appropriately using our energy resources, we can do much to improve not only the quality of the environment, but also the quality of our everyday lives. Vocational education can play a significant role in helping to make these improvements a reality. To do so, however, will require educators to have an understanding of a wide variety of content areas and relationships relevant to a comprehensive approach to energy conservation.

There are six sections in Part One. Each of the sections focuses on a different sector of the Curriculum Content Model. Each section is preceded by an overview page designed to help the reader associate the discussion that follows with the appropriate sector in the Curriculum Content Model. The topical presentation of the discussion in each section is at a general, not detailed level. This is due to the fact that many reference works are currently and readily available to educators. These reference works provide detailed data and information relevant to the concepts described in this portion of the Resource Book. Many of these sources of information are provided in the footnotes and annotated references that follow each section. These should be used as a guide for further study.

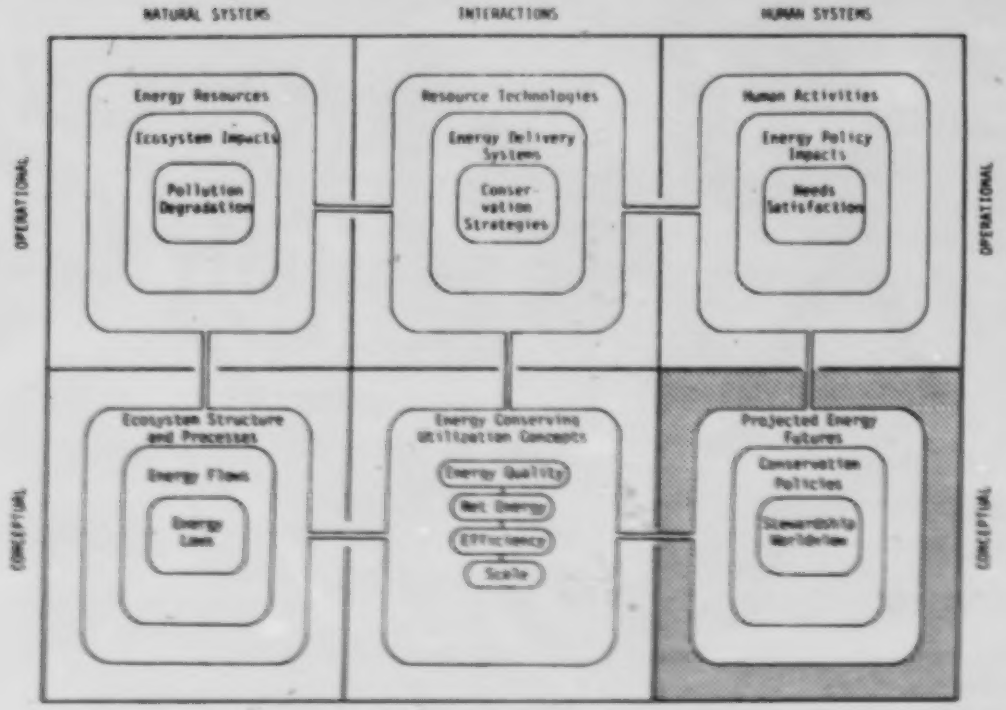
Part Two of the Resource Book contains an extensive bibliography of additional energy-related materials and information resources. These references were not necessarily used in developing Part One. Of particular interest are the lists of films and career-related materials that can be used in classroom instruction. The periodical and information sources listings are valuable in providing the reader with a means to become informed about current research, projects, and activities in energy and environmental areas.

The ultimate purpose, then, of this Resource Book is to provide a context through the Curriculum Content Model framework for the reader to obtain a broad-based and comprehensive understanding of energy conservation and the available materials related to this topic. Many of the issues are complex and require careful and thoughtful study. Indeed, as the reader will discover, more questions may be raised than readily answered. Searching for these answers is the starting point for developing the understanding that will enable us to participate in the personal and collective decision-making process with respect to energy issues.

PART ONE:
KNOWLEDGE COMPONENTS OF THE CURRICULUM CONTENT MODEL

SECTION ONE

ENERGY AND THE FUTURE: A STEWARDSHIP WORLDVIEW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The Energy Conservation Curriculum Content Model Map

The content in this section, derived from the Human Systems: Conceptual sector of the Model, explores the choices we have with respect to our future. At the present time a variety of energy futures are being projected for us. We must examine the characteristics of these futures and their underlying values and beliefs to see if they describe worlds in which we wish to live. Then we must be anticipative to bring about a future we desire. From a conservation standpoint, various futures can be analyzed through an ethic called a stewardship worldview. This worldview implies that we have an obligation to make the world a more humane place for current and future generations.

The discussion on the following pages covers the topics:

- Projected Views of the Future
- Energy Conservation in Future Design
- A Conservation Ethic: A Stewardship Worldview

ENERGY AND THE FUTURE: A STEWARDSHIP WORLDVIEW

At the present time there is a great deal of discussion concerning the role energy will play in our future lives. Individuals interested in pursuing this topic are apt to encounter excessive amounts of information, much of which is difficult to integrate into a cohesive knowledge base from which to make informed decisions. The most confusing aspects stem from our sketchy and inadequate knowledge about the future and our inability to analyze implications of futures being predicted for us. The following quotation summarizes this dilemma with respect to jobs:

> You who are young are often advised to plan ahead--for your education, your job, your career. But how can you plan the 40 to 50 years of your working life when you don't know what kind of work the world will have for you to do?[1]

Instead of viewing this situation from a somewhat passive perspective of "what kind of work will be available," it is possible to approach the dilemma in an active and anticipatory mode. Such an approach requires us to examine possible futures, to understand the career and life-style implications of these projected futures, and to make a conscious choice as to which of these futures we desire. Finally, it requires that we strive to bring about the selected future.

Nowhere is this futures thinking more important than with respect to energy. The fact that many different energy futures are being predicted for us has profound life style and career implications. Energy conservation plays a role in almost all of these futures. Therefore, in order to make intelligent decisions about the future, among the concepts that must be understood are the various energy futures being predicted for us and the meaning of the term, "energy conservation."

The Current Energy Dilemma

Before describing possible energy futures, it is important to describe briefly our present energy dilemma. Much of the current discussion regarding energy originates in what is frequently termed the "energy crisis." More technically this might be called the "fossil fuel crisis." In recent years it has become clear that our economy and resulting life styles depend heavily on fossil fuels. Table 1 presents a picture of our historical energy consumption patterns. It is clear from the data in this table why we are called a fossil fuel economy: over 90% of the energy we consumed in 1976 came from coal, petroleum, and natural gas.

Table 1

HISTORICAL ENERGY CONSUMPTION PATTERNS[2]

YEAR	TOTAL QUADS*	PERCENT OF TOTAL FROM ENERGY RESOURCE				
		FUEL WOOD	COAL	PETROLEUM AND NATURAL GAS	HYDRO-POWER	NUCLEAR
1860	3.1	83.5	16.4	.1	-	-
1880	5.0	57.0	41.1	1.9	-	-
1900	9.6	21.0	71.3	5.0	2.6	-
1920	21.3	7.5	72.8	16.1	3.6	-
1940	25.0	5.3	50.1	40.9	3.7	-
1950	34.0	3.3	38.0	55.9	4.2	-
1960	44.6	-	22.8	73.5	3.7	-
1970	67.1	-	18.9	76.8	4.0	.3
1976	74.3	-	18.5	74.6	4.1	2.7

*A quad is equal to the amount of energy in 172 million barrels of oil.
Source: Bureau of the Census; Bureau of Mines

Table 2 presents a picture of how this energy is consumed by various sectors of the economy. The column labeled electrical generation includes the energy that is used to generate electricity for use in all sectors of the economy. As can be seen in the table, this rate of consumption has doubled since 1950. In 1973, over 80% of the energy used to generate this electricity came from fossil fuels: coal, petroleum, and natural gas.[3] There is therefore another aspect to the energy crisis. We are fast becoming an electricity based economy. Moreover, only about 16 of every 100 kilowatt-hours of potential energy contained in the original fuel are actually converted to useful work.[4]

Table 2

DOMESTIC ENERGY CONSUMPTION BY ECONOMIC SECTOR[5]

YEAR	QUADS TOTAL	PERCENT OF TOTAL				
		COMMERCIAL/ RESIDENTIAL*	INDUSTRIAL*	TRANS-PORTATION*	ELECTRICITY GENERATION	MISCELLAN-EOUS*
1950	34.0	22.3	36.3	25.3	14.7	1.4
1955	39.7	21.6	35.2	24.8	16.6	1.8
1960	44.6	22.8	32.9	24.3	18.5	1.5
1965	53.3	22.2	32.2	23.8	20.8	1.0
1970	67.1	20.8	30.1	24.6	24.2	.3
1976	74.2	20.2	25.4	25.6	28.8	-

*Does not include electricity.
Sources: Bureau of Mines, 1950-1975; FEA, 1976.

Possible Energy Futures

In view of the finite supply of fossil fuel resources, increasing our demand for and dependence on fossil fuels presents a serious dilemma for our society. What, then, are the options proposed for us with respect to obtaining and using the energy we need? In order to examine these options, we can turn to the work of futurists who present images of what the future might look like. Several alternative views of the future have been presented in works such as An Incomplete Guide to the Future;[6] The Next

200 Years: A Scenario for America and the World;[7] Alternative Futures for Environmental Policy Planning: 1975-2000;[8] and A Time To Choose: America's Energy Future.[9]

A Time To Choose: America's Energy Future is particularly relevant for its focus on alternative futures and the prospects for saving energy. In this report, three alternative energy futures are presented: Historical Growth, Technical Fix, and Zero Energy Growth. These three futures are characterized in the following paragraphs.

> Historical Growth. Assumes continued growth in energy use in the United States to the end of the century. It assumes no deliberate effort to alter our habitual patterns of energy use. Instead, it assumes a vigorous national effort directed toward enlarging energy supply to keep up with rising demand.
>
> It is possible, but it would not be easy to fuel the Historical Growth rate. It would mean aggressive development of all available energy sources--oil and gas onshore and offshore, coal, shale, nuclear power. Increased reliance on imported oil could somewhat relieve the pressure on domestic energy sources. In this scenario there would be little scope to pick and choose among sources of supply. No matter how we juggle the mix of sources, coal and nuclear power would have to be the mainstays of energy supply by the year 2000.
>
> Technical Fix. Reflects a conscious national effort to use energy more efficiently through engineering know how--that is, by putting to use the practical, economical, energy-saving technology that is either available now or soon will be. The effect on the way people live and work would be quite moderate.
>
> Supply options are more flexible in this scenario. The slower growth in energy consumption would permit more flexibility and a more relaxed pace of development. The nation could halt growth in at least one of the major domestic sources of energy and still demand less from other supply sources than Historical Growth would require.
>
> Zero Energy Growth (ZEG). Does not require austerity, nor does it preclude economic growth. It includes all the energy-saving devices of Technical Fix, plus extra emphasis on efficiency. Its main difference lies in a small but distinct redirection of economic growth, away from energy-intensive industries toward economic activities that require less energy. Compared with the other energy futures, a ZEG future would have less emphasis on making things and more on offering services.

ZEG would allow still more choice in supply from conventional sources. After 1985 this scenario could also permit use of cleaner, renewable, but smaller scale energy sources (such as windpower, rooftop solar power, and recycled waste) to meet a larger share of the total energy demand. Still, it should be remembered that even in this scenario the national energy appetite would be very large.

Discussions of energy conservation are common to almost all discussions of energy futures. The term "conservation," however, takes on different meanings in each. To some, conservation implies only short-term, stopgap measures involving temporary reductions in energy consumption or demand necessary until new energy production technologies are available. To others conservation implies mainly the application of "technical fixes" or energy saving technologies such as insulation, improved auto efficiency, etc. Alternatively, energy conservation is sometimes taken to mean the development of non-conventional energy resources such as solar or geothermal energy. And to others, conservation means the return to simpler life styles. Thus, there are various meanings for conservation and it is important to understand exactly what one means when using the word in describing various energy futures.

Energy Conservation and a Stewardship Worldview

The most comprehensive way to view energy conservation is as an ethic which can be best described through what we have chosen to call a "stewardship worldview." A worldview is a set of core beliefs at the individual or aggregate level concerning the nature of human beings. These core beliefs, being neither verifiable nor demonstrable, are based on certain assumptions and values about what is assumed to be true and what is hoped will become true in the future.

A worldview, reflecting cultural experiences that were part of our early socialization, influences in direct and subtle ways how we perceive and judge our experiences. In this, it provides a framework which shapes our attitudes, behavior, and values and which can be used in assessing alternative futures.

Worldviews are constantly in the process of evolving. The prevalent worldview, with its origins in the first part of this century, is beginning to undergo observable transformation. What is emerging, and what can be subsequently used as an ideal image in designing and assessing the desirableness of projected futures, may be characterized as a stewardship worldview. The stewardship approach is oriented toward enhancing our quality of life while maintaining a harmonious relationship with the biophysical systems that support our existence.[10]

This evolving worldview requires us to evaluate our dreams for the future in terms of the demands placed upon our life support systems. It is based upon the notions that: (a) humans can cause irreversible changes in nature, (b) our environmental resources are limited, (c) our environment has a limited capacity to absorb waste and pollution, and (d) a finite world with finite resources cannot support an indefinitely expanding population, technology, or economy.

A stewardship view of energy conservation is based on the belief that we can do better in the future than we have in the past to use all resources, particularly energy resources. By doing better with our resources, we can reduce our energy demands. But it is not only the quantity of energy that is important; in the long run, how this energy is used is of importance. We must be concerned not only with how much energy we are using, but also with how we are using it to contribute to a quality human and physical environment.

Thus, a stewardship view of energy conservation includes those energy strategies that preserve and enchance the quality of human life and the natural system. To do so, in some instances, we can simply reduce energy demands; in others, we must develop non-conventional energy technologies and improve the efficiency of our technologies. It will not necessarily be easy to implement comprehensive energy conserving strategies in the future. The stewardship worldview, however, does present us with a framework from which to start. Our hope is that by implementing sound energy policies based on a stewardship view of energy conservation, we can bring about a future desired by all.

Summary

In response to our current energy problems, experts are predicting a variety of energy futures for us. In order to be anticipative and bring about an energy future we desire, we should understand the nature of these energy futures and their implications for our quality of life. This is particularly true with respect to the meaning of the term "energy conservation." Although there are varying meanings of this term, one of the most encompassing definitions is associated with an energy ethic, included within a stewardship worldview. From a stewardship worldview, conservation implies those energy policies that preserve the quality of the environment and promote the equitable satisfaction of human needs.

ENERGY AND THE FUTURE: A STEWARDSHIP WORLDVIEW

FOOTNOTES

1. Odom Fanning, Opportunities in Environmental Careers, (Louisville, Kentucky: Vocational Guidance Manuals, Inc. 1975).
2. U. S. Department of Energy, Energy in Focus: Basic Data (Washington, D.C.: U.S. Department of Energy, January, 1978), p. 2.
3. John W. Fowler, Energy-Environment Source Book (Washington, D.C.: National Science Teachers Association, 1975), p. 134.
4. Carol Steinhart and John Steinhart, Energy: Source, Use and Role in Human Affairs (North Scituate, Massachusetts: Duxbury Press, 1974), p. 141.
5. U.S. Department of Energy, p. 3.
6. Willis Harman, An Incomplete Guide to the Future (San Francisco: San Francisco Book Company, 1976).
7. Herman Kahn, William Brown and Leon Martel, The Next 200 Years: A Scenario for America and the World (New York: William Morrow and Company, 1976).
8. Duane S. Elgin, David C. MacMichael, and Peter Schwartz, Alternative Futures for Environmental Policy Planning: 1975-2000 (Menlo Park, California: Stanford Research Institute, 1975).
9. Energy Policy Project of the Ford Foundation, A Time to Choose: America's Energy Future (Cambridge, Massachusetts: Ballinger Publishing Company, 1974).
10. Wendell Berry, "Exploration and Nature," The Co-Evolution Quarterly (Spring, 1977), pp. 56-21.

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REFERENCES FOR FURTHER STUDY

Cornish, Edward. The Study of the Future: An Introduction to the Art and Science of Understanding and Sharing Tomorrow's World. Washington, D.C.: World Future Society.

This volume provides a brief, readable introduction to the study of the future. The authors present a rationale for future study, basic principles of futurism, and methods for studying the future. The ideas of several noted futurists are also presented. These include Margaret Mead, Daniel Bell, Willis Harman, Herman Kahn, and many others. An appendix providing references to major resource centers, associations, and periodicals in also provided.

Ford Foundation. A Time To Choose: America's Energy Future. New York: Ballinger, 1974.

This volume is the final report to a $4 million, 3-year study sponsored by the Ford Foundation. The report focuses on three possible energy futures: Historical Growth, Technical Fix, and Zero Energy Growth. Each is examined for their impact on employment, economic growth, and the environment.

Harman, Willis W. An Incomplete Guide to the Future. San Francisco: San Francisco Book Company, 1976.

This volume is a synthesis of Harman's thinking in which he describes the pervasive transformation he feels society will undergo in the next few years. This transformation will occur because the industrial orientation of our society has led to critical problems that cannot be resolved.

Kahn, Herman; Brown, William; and Martel, Leon. The Next 200 Years: A Scenario for America and the World. New York: William Morrow and Company, 1976.

This volume, produced by Kahn and his colleagues at the Hudson Institute, presents an optimistic view of America's future. The authors suggest that the problems of shrinking supplies of fossil fuels and increasing pollution can be overcome. This work should be contrasted with Miles' Awakening from the American Dream.

Miles, Rufus E., Jr. Awakening from the American Dream--The Social and Political Limits to Growth. New York: Universe Books, 1976.

In this book, Miles analyzes 22 determinants, that he feels have brought American society to its present state. Based on his analysis, Miles expresses a highly pessimistic view of the future. He believes American society is highly vulnerable to further social deterioration, sabotage, and breakdown. This work should be contrasted with The Next 200 Years, by Kahn, et al.

Nash, Hugh (ed.). Progress As If Survival Mattered: A Handbook for a Conserver Society. San Francisco: Friends of the Earth, 1977.

According to the foreword, this is a how-to-do-it book of steps toward, and rewards of, applying conservation conscience to many fields of human activity. To this end, a variety of authors have contributed articles dealing with a number of important topics for the future: population, energy, transportation, health, etc. The graphics, pictures, and added side material help to make this volume highly readable.

Schumacher, E. F. Small is Beautiful: Economics As If People Mattered. New York: Harper and Row, 1973.

In this book, Schumacher develops the theory and practice of Intermediate Technology. It deals with the economics appropriate for current resource conditions and contains insights into the need for restructuring our principles, actions, and dreams on a more equitable and rewarding basis.

RELEVANT JOURNAL ARTICLES

Jones, W. T. World views: Their nature and function. Current Anthropology, 13(1), 1972, 79-109.

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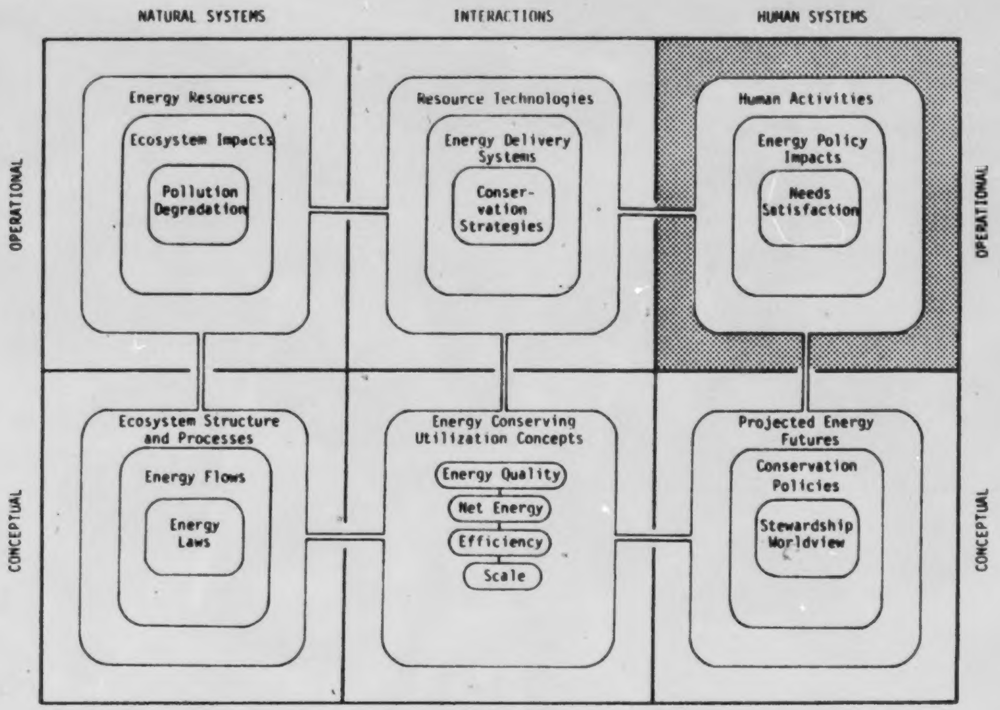
SECTION TWO

HUMAN SYSTEMS NEEDS: JOBS AND ENERGY CONSERVATION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The Energy Conservation Curriculum Content Model Map

The content in this section, derived from the Human Systems: Operational sector of the Model, focuses on the relationships between energy and the activities of the human system. At the individual and collective level, most of these activities are related to the satisfaction of human needs. To make intelligent choices for the future, we must examine the interrelationships between energy policies and factors associated with a high quality of life such as adequate health care, transportation, shelter, etc. All of these human concerns are included in this sector; however, because the Curriculum Model is targeted for post-secondary adult and vocational education, the content focuses on energy, economic, and job relationships. Energy conservation has the potential to affect both the quantity and quality of all job opportunities. Likewise, all workers can contribute to the better use of energy.

The discussion on the following pages covers the topics:

Energy, GNP, and Economic Growth
Energy Intensities and Jobs
Energy Conservation and Job Opportunities

HUMAN SYSTEMS NEEDS: JOBS AND ENERGY CONSERVATION

Energy is of importance to people because it provides the means for satisfying human needs. Among these are our needs for shelter, health, recreation, family and social relationships, and jobs. Policies that directly or otherwise influence the type of energy resources utilized and their availability, in turn, also influence our opportunities to satisfy these basic human needs. And most of the activities of the human system are related to the efforts of people to satisfy their needs.

Current and future energy policies can be analyzed from the perspective of their influence on satisfying any of our basic needs or human system activities (e.g., health, shelter). One of the most fundamental of these needs in our society is the need for meaningful and gainful employment. The jobs we have and our satisfaction with them influences many of the other factors associated with a high quality of life (e.g., health, education, shelter). It is therefore important to examine future energy policies from the perspective of their implications for meaningful job opportunities. It is equally important to consider how current jobs may be affected by future energy policies.

Specifically, in examining future energy policies, we are most interested in focusing on the role energy conservation will play in opening up or closing off job opportunities. There is a great deal of misunderstanding with respect to this topic. Some fear that policies that emphasize energy conservation or serve to limit the development of any or all energy resources will result in fewer job opportunities and a lowering of the quality of our lives. This is not necessarily the case. In order to understand how conservation strategies, particularly those emphasizing the wise use of all resources, may affect work opportunities, it is important to examine several key relationships between energy, economics, and jobs.

Energy, GNP, and Economic Growth

The Gross National Product (GNP) is the traditional measure of a country's well-being. The GNP is a dollar measure of all the goods and services produced in a country. A large per person or per capita GNP usually indicates that a country has a high standard of living; conversely, a low per capita GNP usually means a country has a low standard of living.

Energy contributes to the GNP in two ways. First, energy is a good in the form of petroleum, electricity, etc. produced by some of our major industries. Secondly, this energy is a resource used by other industries who use it along with capital, other raw materials, and labor to produce goods and services (e.g., automobiles, clothing, food).

For the past 40 years or so, up until at least the 1970's, there has been a strong positive relationship between the rate of energy consumption in the U.S. and the size of the GNP.[1] As energy consumption increased, so did the GNP. This fact has led to the conclusion that large amounts of readily available energy were needed for, or even created, the economic growth. Conversely, it is believed that if this energy is not available for consumption, there will be a decline in economic growth with a resultant loss of available jobs.[2] More recent analyses, however, have indicated that the relationship between GNP and energy growth is not so iron-clad.

For instance, when one examines energy consumption in countries having a standard of living comparable to the U.S., the relationship between GNP and energy consumption becomes less clear-cut. Japan, Sweden, West Germany, and Switzerland have high standards of living and high GNPs, but use substantially less energy than does the United States.[3] Indeed, Americans use as much as two times the energy per person as do West Germans, Swedes, and the Swiss.

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Yet, the unemployment rate in these nations is much lower than in this country.[4]

There are a number of factors that can account for these differences between energy consumption and GNP in various countries. These include climate, personal life style habits, form of government, and the types of industry that make up the economy. With respect to the types of industry in the economy, of particular importance is their efficiency of operation (a discussion of efficiency is included in Section Five), their energy and capital requirements, and the jobs they provide.

The Energy and Capital Requirements of Jobs

The energy content of goods and services, expressed as the unit of energy input per unit output, is often referred to as their energy intensity.[5] To determine the energy intensity required to make an automobile, for example, we would need to know the amount of energy consumed directly and indirectly by the auto industry and add it to the energy represented in all other components required to make a car such as tires, glass, etc.[6] By doing this we would find, for instance, that products such as high grade steel and aluminum are more energy-intensive products than lower grade metal or glass products; synthetic fibers are more energy intensive than cotton or wool. Moreover, for the last few decades the energy intensities of various goods and services in our economy have been increasing.[7]

Aside from the fact that the production of certain products inherently requires more energy (e.g., synthetic fibers), there are other reasons why the energy intensities of various products have been increasing. One of the major reasons is that energy in the form of automated technology has been substituted for labor in many of our production processes. Because historically energy and other material resources were relatively cheap compared to labor, it was more efficient and cost effective to substitute human labor with automated technology.[8] Thus, the energy intensity of the product increases and the labor intensity (unit of labor input per unit output) decreases. Although in many instances, this has resulted in less drudgery in the work place, it is also possible that in some instances meaningful jobs were eliminated and the remaining jobs became less satisfying.

Bruce Hannon has calculated the relative energy intensities for various consumer purchases in 1971 and their associated labor intensities.[9] Several of these intensity values are shown in Table 1.

Table 1

ENERGY AND LABOR INTENSITIES OF PERSONAL CONSUMPTION ACTIVITIES IN THE U.S. IN 1971

Personal Consumption Expenditures Description	Energy Intensity (BTUs/$)	Labor Intensity (Labor unit/$)
Electricity	502,473	.044
Gasoline and Oil	480,672	.073
Cleaning preparations	78,120	.073
Kitchen and household appliances	58,724	.096
New and used cars	45,593	.089
Food purchases	41,100	.085
Furniture	36,664	.092
Clothing	32,253*	. 99*
Religious and welfare activity	27,791	.086

*Figures are averages based on Hannon's data.

The table values indicate that for each consumer dollar spent on electricity, 502,473 British Thermal Units of energy were required, but only 44/1000 of a job unit. This contrasts, for example, with expenditures for kitchen and household appliances, which require roughly 1/9 as much energy but more than twice the number of labor units.

It is interesting to note that our current energy-producing industries themselves (electricity, oil, etc.) have high energy intensities. Between 1950 and 1971, total U.S. national employment increased 41%; employment in the energy-producing industries increased only 5.5%.[10] During this period the amount of energy produced by these industries increased greatly. All in all, the major energy-producing and energy-using industries consume about 1/3 of the nation's energy, but provide only about 10% of the nation's jobs; [11] and these industries account for only about 15% of the nation's GNP.[12] Indeed, the great bulk of U.S. energy consumption is tied to industries that have generated almost no new jobs in the past two decades.[13]

It is very tempting to believe that if we were to build large-scale nuclear reactors or electrical production plants to meet future energy needs, large numbers of new types of jobs would be created. Aside from the fact that these large-scale technologies require large amounts of energy for their operation but require a relatively small proportion of workers, this is also a very expensive way to create jobs.

Estimates based on our current highly technological and fossil fuel dependent industries indicate that large capital investments will be required if we are to meet future needs on a "business as usual" basis (minimal attention to energy conservation). O'Toole has compiled several estimates of these capital investment requirements made by various agencies. The figures range from 550 billion dollars to 1.7 trillion dollars.[14] To put these financial requirements into perspective, they can be compared to the 25 billion dollars required by Project Apollo to put U.S. spacemen on the moon.[15] If we were able to meet these capital requirements, there would be very little money left over for investment in other sectors of the U.S. economy.

Moreover, per dollar of capital investment, relatively fewer jobs can be expected from this investment than from comparable investments in other industries, particularly service industries. Part of the reason for this is the fact that the capital investment goes for the development of machines and technologies that replace human labor. In 1977, the Conference Board produced a report indicating that the capital investment needed to create a job in energy-intensive industries was on the average much higher than the investment to create a job in industries requiring smaller amounts of energy.[16] Several of these figures are presented in Table 2.

Table 2

CAPITAL INVESTMENT PER JOB

Industry	Capital Investment Per Employee
petroleum	$108,000
public utility	105,500
chemicals	41,000
primary metals	31,000
manufacturing (overall average)	19,500
textile mill production	11,000
wholesale and retail trade	11,000
services	9,500

It is sometimes claimed that the indirect employment created by the major energy and capital intensive industries is substantial. That is, although the industry itself employs only a small proportion of the work force, the expenditures in this industry create jobs in other sectors of the economy (e.g., construction, education, health, etc.). While this is partly true, it is also true that any investment leads to indirect job creation. Bezdeck and Hannon recently demonstrated that for an identical investment of five billion dollars, the government could create 423,000 new jobs for a health program or 256,000 new jobs in a highway program.[17] Given almost the same choice, the government chose the highway program.

What these facts and figures indicate is that, in general, there are many trade-offs between energy, the elements of economic growth, and jobs. These are sometimes sound and necessary economic and social reasons why industries must be energy or capital-intensive. Aluminum production is energy intensive; yet, aluminum is necessary in certain structural uses. It is not clear, however, that it is absolutely needed as a beverage container.

A number of economic analyses have indicated that by taking advantage of these trade-offs, comprehensive energy policies that emphasize a broad approach to energy conservation measures will not necessarily result in fewer jobs, but in fact have the potential to lead to increased employment.[18] For example, a recent Wall Street Journal article reported that efforts to clean up air and water pollution over the next few years alone may result in a .2 to 3% reduction in the nation's unemployment rate.[19] Of course, the amount of energy that could have been saved by not having this pollution in the first place can only be speculated.

Energy Conservation and the Quality of Life

It is important, however, to consider not only the *quantity* of jobs that may be created, but also their *quality*. There is increasing evidence that dissatisfaction with many of the jobs in our industrial society is increasing.[20] Moreover, information on the effects of air pollution on health, the incidence of "black lung" disease on coal miners, and the Three Mile nuclear reactor accident are indicative of the relationship between energy policies and the health and safety of workers. So, simply to create more jobs through energy conservation that are unsatisfying or potentially unsafe would be of no real benefit to anyone. There is some suggestion, however, that energy conservation approaches may result in increased opportunities for meaningful jobs. Particular attention should also be given to minimizing the possible health and safety risks that may be associated with these occupations.

If, for example, solar energy technology were to be developed on a scale so that it could do the jobs for which it is best suited (e.g., small scale heating and cooling) a vast new industry would be developed; it is, in fact, already developing. A recent ERDA report indicated that the job mixture in solar energy systems would require a wide diversity of skills in the design, manufacture, installation, and maintenance of these solar systems. Nine tradespersons would be utilized for every one professional scientist or highly skilled technician.[21] By comparison, the ratio for nuclear energy systems is two to one. Moreover, the solar jobs would be in local areas rather than in remote areas, where large-scale nuclear or coal production systems must be located.

Additionally, as the American public pays more attention to energy requirements of goods (either through increased consciousness or rising prices), the demand for more durable, efficient, and energy-conserving consumer products can be expected to increase. It would not require major technological advances for

U.S. industries to produce more efficient products such as automobiles and refrigerators. It would, however, require additional capital and energy for industries to change their current methods to produce better products; it would also require more labor.[22]

Although the consumer may pay an initial higher price for these products because of the added industrial investment, these extra costs could result in energy dollars saved over the longer life of the product. Additional jobs would be created in the industries or occupations that service these products, such as automobile and appliance repair.[23] Lovins, for example, states that even such a simple step as making efficient home applicances would result in about twice as many jobs as would result from building more power stations to provide energy for inefficient appliances.[24] Moreover, the jobs that would be created in areas such as the repair industry are usually regarded as more meaningful than those associated with the assembly line production of inefficient, throwaway products.

Even more jobs would be created when the consumer spends the dollars saved from reduced energy costs of products for personal consumption expenditures. These personal consumption expenditures are usually less energy-intensive and more labor-intensive.[25] These expenditures also contribute directly to the consumer's sense of well-being, while money spent on wasted energy does not. Moreover, the jobs created from these expenditures tend to require human skill, ingenuity, and a pride in craft.

To save energy and create jobs in this fashion does, however, require careful consideration and planning. There is always the possibility that energy-saved dollars could be spent on energy-intensive activities. Likewise, it would be unwise to develop our alternative energy resources to such an extent that they become capital- and energy-intensive. This possibility would exist, for example, if we were to develop large-scale highly complex energy systems to produce electricity--an end use for which it is probably not suited.

We must therefore be guided by our visions for a desired future. James O'Toole has described the characteristics he envisions for a future quality economy.[26] Comprehensive energy conservation policies may help to make this dream a reality. His characteristics are:

- a reduction in pollution-causing waste and inefficient use of energy and other raw materials;
- full employment in meaningful jobs; and
- production of goods and services that enhance the quality of life.

Preparing for Energy Conservation and Job Opportunities

What then are the opportunities for specific jobs in the future in energy industries and in energy conservation? Specifically, how will current jobs be impacted by energy conservation? How can an individual prepare for these jobs? These are all extremely important questions. Yet, there are no ready answers. We are just beginning to understand that the need to conserve energy may open up more alternatives than it closes off. Indeed, John Tuve, in his book on the problems of Energy, Environment, Populations and Food, has concluded:

> Whatever our concerns over slow future growths and shortages of energy, food, or living space, we must admit there never was a time when the long-term future offered more challenges to the individual American. There are so many things to be done with plans already suggested; and there never was a better economic system or political climate inviting their accomplishment.[27]

We are just beginning to understand these challenges and to understand fully that energy conservation means doing more and better with all of the energy resources available to us.

No one, however, has done any systematic analyses of the employment opportunities associated with specific energy conservation strategies. In part, this is because we do not yet have a comprehensive energy policy in this country.

However, using the broad-based goals of energy conservation and energy-use concepts (efficiency, net energy, end use, etc.), we can identify a wide variety of areas where jobs should arise if we were to implement a comprehensive energy conservation policy.

1. Job opportunities should arise in alternative energy technologies: solar, geothermal, wind, etc. As indicated earlier, this will require a variety of skills related to design, development, installation, and maintenance of these systems. Attention should be paid, however, to ensuring that these systems are developed to do the jobs for which they are best suited and that no single one of these technologies is used as a quick and easy answer for meeting all of our energy needs.

2. With respect to current conventional energy technologies, lessons from the past indicate that relatively small numbers of new jobs will be needed. This would be true even under the policies that push the development of these conventional technologies (e.g., petroleum, nuclear power). Although there might be an increased demand for certain occupational skills such as construction or pipe fitting, many of these jobs would be temporary and in remote locations. The development of the Alaskan pipeline is a good example of this temporary increase for workers.

Under energy conservation policies, even conventional energy technologies would need personnel who can deal with conservation strategies. These would include waste heat recovery, power plant system efficiency, and load management programs.

3. There will also be a need for jobs in areas related to air and water pollution quality and control. Much of this pollution can be attributed to our application of energy technologies and the energy-wasting products and life styles that these technologies have produced. We must correct as much as possible of the damage that has already been done, even though we would have insured the better use of our future resources if this damage were prevented in the first place. We cannot ignore the problem now that it exists.

4. In all technologies, not just in those related to energy production, there will be a need for workers who are competent in increasing the energy efficiency of technologies, decreasing their energy intensiveness, developing technical fixes for problems that now exist, and preventing future wastes. In many cases, it seems likely that these competences will be needed in addition to the usual competence needed to enter the particular technological field. Therefore, there may be an increased demand for "energy conservation specialists." In addition, it is important that all of us learn to use energy efficiently in our jobs, regardless of whether or not they are specifically related to energy conservation. Workers skilled in the efficient use of energy will be an asset to any company.

Due to the vast inefficiencies with respect to most of the end-uses of energy, there are numerous examples of where these demands might arise. Increasing the energy efficiency of physical plant management, developing strategies for recycling wastes, developing more efficient technologies in transportation, home construction, developing methods so that agricultural practices are less energy-intensive are only a few of the areas where opportunities should arise.

5. There will be a demand for people who can provide consumer education to the public. The public needs to be able to exercise appropriate marketing strategies and to apply energy conserving strategies to their own lives. These jobs could appear in utilities, educational agencies, social welfare agencies, labor unions, major product manufacturing plants, and government.

6. There will be a demand for people who are skilled in dealing with the legal, social, economic, and physical consequences of various energy policies and energy conservation strategies. As of mid-1976, it was estimated that 16,500 jobs had been lost because obsolescent industrial plants could not meet air or water pollution standards.[28] Even though approximately 300,000 new jobs were created in environmental clean-up industries,[29] the individuals who lost these jobs are important. Strategies will have to be developed to deal with these temporary dysfunctions in the labor market and persons will be needed to implement these strategies. Additional opportunities can be expected to arise in the environmental law and environmental health fields.

The list of potential job opportunities is almost endless. Energy conservation has far-reaching consequences for each person. Indeed, with respect to jobs and energy conservation, the issue in the future may not be a shortage of jobs; rather, we may be faced with a shortage of competent workers.

Does this mean, then, that no jobs will be eliminated because of energy conservation? The answer is undoubtedly dependent upon the speed with which we begin comprehensive energy conservation planning and implementation. Certainly, any abrupt disruption in our energy supplies will cause severe cutbacks, and jobs will be lost in the short run. If we do not begin conserving energy now, individuals should consider how energy concerns may affect job stability before entering an energy-intensive field. In addition, all workers should consider the health and safety factors associated with an energy-intensive occupational field--e.g., coal mining.

To bring about an energy future based on a stewardship view of energy conservation requires citizen support and cooperation. We have, however, had ample warning. If we begin now to use energy wisely at home and in whatever job we have, we will be helping to ensure that there will be future job opportunities for all. It will be the workers who are competent in their fields and who have a strong energy conservation ethic and understanding that will be at the forefront to take advantage of these opportunities.

Summary

A large number of important relationships exist between energy production and utilization and the activities of the human system. The ways in which we satisfy human needs through energy-using technology should be examined to see how wisely we are using the energy available to us. Likewise, energy policies should be assessed to ascertain how they influence our efforts to have a high quality standard of living. The relationship between energy, economics, and jobs is of particular importance because these factors are related to the satisfaction of many other needs. A broad approach to energy conservation in our society has the potential to result in increased occupational and training opportunities in a wide variety of areas. In addition, to effectively deal with our nation's energy problems, all citizens and workers must attempt to use energy more wisely at home and on the job.

HUMAN SYSTEMS NEEDS: JOBS AND ENERGY CONSERVATION

FOOTNOTES

1. The relationship between energy production or consumption and GNP is discussed in numerous reference books. See, for example, Lee Schipper, "Energy Conservation: Its Nature, Hidden Benefits and Hidden Barriers," Energy Communications, II, 4 (1976), pp. 331-414; John Fowler, Energy-Environment Sourcebook (Washington, DC: National Science Teacher Association, 1975, pp. 47-55; and Richard Grossman and Gail Daneker, Jobs and Energy (Washington, DC: Environmentalists for Full Employment, 1977).

2. Schipper (see reference 1) cites ads appearing in national magazines that say "Generate less electricity. Sure. And generate galloping unemployment!"

3. James O'Toole, Energy and Social Change (Cambridge, MA: The MIT Press, 1976), p. 15.

4. Grossman and Daneker, p. 5.

5. O'Toole, p. 24.

6. Clark Ballard III, Bruce Hannon, and Robert Henderson, Energy Flow Through the United States (Urbana, IL: University of Illinois at Urbana-Champaign, 1976). Definition appears on their wall chart legend.

7. O'Toole, pp. 24-31.

8. Bruce M. Hannon, "Energy, Growth and Altruism." (Urbana, IL: Energy Research Group, Center for Advanced Computation, University of Illinois at Urbana-Champaign, 1976). (Mimeographed)

9. Bruce M. Hannon and F. Puleo, "Transferring from Urban Cars to Buses" (Urbana, IL: Energy Research Group, Center for Advanced Computation, University of Illinois at Urbana-Champaign, 1974).

10. Energy Policy Project of the Ford Foundation, A Time To Choose: America's Energy Future (Cambridge, MA: Ballenger Publishing Company, 1974), p. 141.

11. Energy Policy Project of the Ford Foundation, p. 141.

12. Herman Daly, "Electric Power, Employment, and Economic Growth," in Herman Daly (ed.), Towards a Steady State Economy (San Francisco, CA: W. H. Freeman and Company, 1973).

13. Energy Policy Project of the Ford Foundation, p. 143.

14. O'Toole, p. 52.

15. O'Toole, p. 52.

16. The Conference Board, *Capital Invested*. Cited in Grossman and Daneker, p. 6.

17. Roger Bezdek and Bruce Hannon, "Energy, Manpower, and the Highway Trust Fund," *Science*, 185 (August 23, 1975), pp. 669-675.

18. See, for example, Lee Schipper (reference 1), James O'Toole (reference 3), and Meg Schachter, "The Job Creation Potential of Solar Energy Conservation: A Critical Evaluation" (Washington, DC: Advanced Energy Systems Policy Division, Department of Energy, 1978). (Mimeographed)

19. "Pollution Controls Boost Inflation Rates Slightly Study Says," *Wall Street Journal*, January 27, 1979.

20. One of the most comprehensive reviews of the literature on attitudes of workers toward jobs can be found in Robert Peterson and James Johnson, *The Work Ethic in Career Education Materials* (San Francisco: Far West Laboratory for Educational Research and Development, 1978).

21. Federal Energy Administration, *Project Independence Labor Task Force Report*. Cited in Grossman and Daneker, p. 15.

22. Schipper, pp. 366-372.

23. Schipper, pp. 366-372.

24. Amory Lovins, *Soft Energy Paths: Toward A More Durable Peace* (San Francisco: Friends of the Earth International, 1977), p. 33.

25. Schipper, pp. 366-372.

26. O'Toole, p. 123.

27. George L. Tuve, *Energy, Environment, Population, and Food* (New York: John Wiley and Sons, 1976), p. 203.

28. Russell Peterson, "Economic Justice," in Hugh Nash (ed.), *Progress As If Survival Mattered* (San Francisco: Friends of the Earth, 1977), p. 83-87.

29. Peterson, pp. 83-87.

REFERENCES FOR FURTHER STUDY

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The Ford Foundation. A Time To Choose: America's Energy Future. New York: Ballinger Books, 1974.

The objective of this volume is to explore various energy futures from the perspective of energy conservation. In so doing, the authors explore the relationship of these futures to the economy. Their principal finding is that energy growth, economic growth, and employment are interdependent but are in no way linked inevitably to the patterns of the path.

Fanning, Odom. Opportunities in Environmental Careers. Louisville, KY: Vocational Guidance Manuals, Inc., 1975.

This volume presents an introduction to a wide variety of environmental careers. The author describes a number of two- and four-year environmental education curricula, as well as specific occupational fields in environmental protection, public health, biology, ecology, conservation, recreation, environmental design, and land use planning. A noticeable ommision is any discussion of energy-related fields.

Grossman, Richard and Daneker, Gail. Jobs and Energy. Washington, D.C.: Environmentalists for Full Employment, 1977.

This short pamphlet explores the issues behind the argument that creating large-scale complex energy systems is the only way to meet the energy needs of the nation, to provide a strong economy, and to create jobs. Instead the authors contend that increased energy efficiency plus solar energy can provide a prosperous economy.

Nash, Hugo (ed). Progress As If Survival: A Handbook for a Conserver Society. San Francisco: Friends of the Earth, Inc., 1977.

The chapters in this volume are written by specialists in different fields, each of whom presents a conservation viewpoint of such diverse topics as population, education, agriculture, and foreign policy. Each focuses on conservation strategies, with recommendations for specific actions. The energy chapter by Amory Lovins, and the sections on jobs and the environment edited by Cynthia Johnston are especially worthwhile.

O'Toole, James. Energy and Social Change. Cambridge, MA: The MIT Press, 1976.

This volume contains a synthesis of several analyses of possible energy futures completed or commissioned by the Center for Futures Research at the University of Southern California. The author suggests that the challenges of the energy crisis provide valuable opportunities and options that can contribute to a quality economy with meaningful jobs.

Yudelson, Jerry and Nelson, Lynn. Right Livelihood, Work and Appropriate Technology. A report to the California Office of Appropriate Technology. Berkeley, CA: Environ/Mental, 1976.

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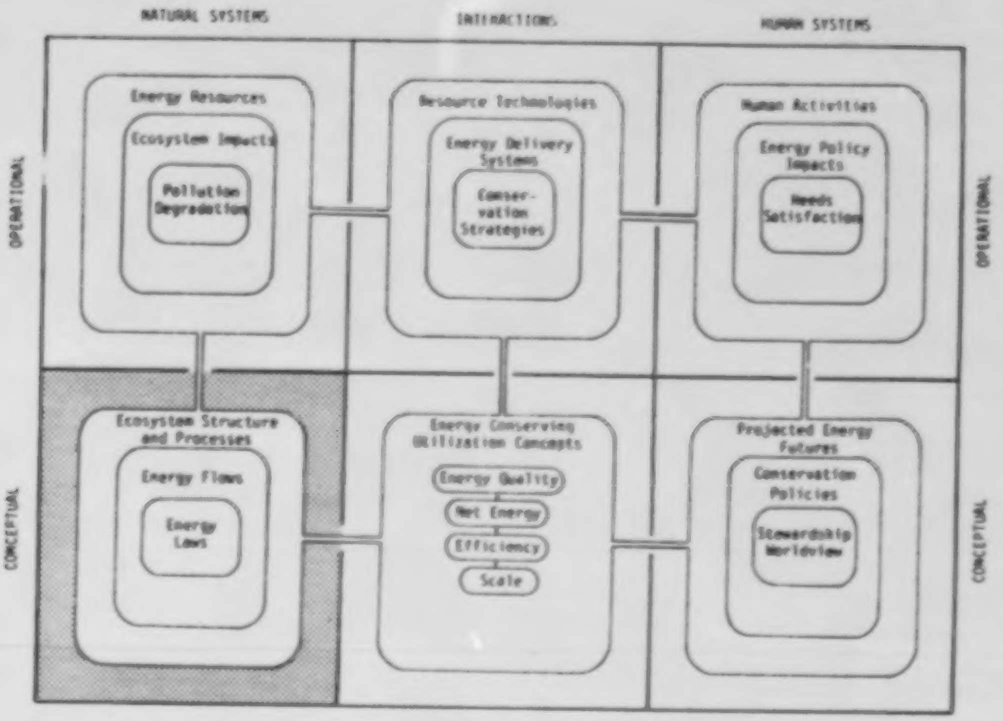
Yolton, John. "Jobs, Economic Justice and the Environment." In The Report of the North American Regional Seminar on Environmental Education, edited by James L. Aldrich, Anne M. Blackburn, and George A. Abel. Columbus, OH: ERIC/SMEAC Center for Science, Mathematics, and Environmental Education, 1977.

SECTION THREE

ENERGY AND THE NATURAL SYSTEM


NATURAL SYSTEMS
INTERACTIONS
HUMAN SYSTEMS
OPERATIONAL
OPERATIONAL
Energy Resources
Ecosystem Impacts
Pollution Degradation
Resource Technologies
Energy Delivery Systems
Conser-vation Strategies
Human Activities
Energy Policy Impacts
Needs Satisfaction
CONCEPTUAL
CONCEPTUAL
Ecosystem Structure and Processes
Energy Flows
Energy Laws
Energy Conserving Utilization Concepts
Energy Quality
Net Energy
Efficiency
Scale
Projected Energy Futures
Conservation Policies
Stewardship Worldview

The Energy Conservation Curriculum Content Model Map

The content in this section, derived from the Natural Systems: Conceptual sector of the Model, focuses on the structure and functioning of the natural system and its component ecosystems. The natural system is the ultimate origin of all energy resources. Energy flows through these systems as they strive to maintain a dynamic equilibrium often referred to as ecological balance. The laws of thermodynamics and the necessity for maintaining ecological balance provide the initial fundamental conceptual bases for understanding the significance of energy conservation.

The discussion on the following pages covers the topics:

Ecosystems and Equilibrium
Laws Governing Energy Flows
Analysis of Energy Flows

ENERGY AND THE NATURAL SYSTEM

Up until approximately 10,000 years ago, the activities of human beings did not greatly affect the natural and physical environment. According to Paul Ehrlich, as humans adopted agricultural practices, the relationship between humans and the natural system changed dramatically.[1] It was at this point that humans gained the ability to influence their environment on a much larger scale. Through the years, humans have increasingly exercised this capacity to change their surroundings as we have developed almost entirely human-designed technological environments. Far too often, however, these changes have been made with little thought given to functioning of the natural system.

The natural system is the ultimate origin for all resources. There are certain fundamental laws and principles governing the flows of these resources and the functioning of the natural system. These laws and principles ultimately influence and, in fact, define the limits of what human developed technologies can and cannot do. Thus, before we can select appropriate energy conservation policies for the future, it is important to understand the dynamics of natural systems and the energy laws which should influence our choices so that the human system can exist in harmony within the natural system.

Ecosystems and Equilibrium

The concept of a natural system, or even several natural systems, is very broad and difficult to visualize. It may be more convenient to refer to an ecosystem. A system is a functional whole composed of organized, interacting, interdependent parts and elements.[2] An ecosystem is, thus, a functional system which includes the organisms of a natural community together with their environment.[3] An ecosystem may be a forest, a pond, a fallen log, or a garden. It is any area with a boundary through which the input and output of energy and materials can be measured and related to some unifying environmental factor.[4] The boundaries drawn around an ecosystem are arbitrary and selected for convenience in studying them.

Ecosystems function through two important processes: chemical cycling and energy flow. Chemical cycling is the process whereby the chemicals necessary for life such as carbon, water, or oxygen are continuously cycled and recycled through the ecosphere (sum total of all of the various ecosystems on the planet).[5] Because the supply of these elements is finite, matter must be reused constantly in order for life to be maintained.

Energy, defined as the capacity to do work, is described as flowing because unlike essential chemicals, energy is not recycled--it flows in one direction through the ecosphere and back into space. As energy flows through an ecosystem, it may go through several transformations. Light may be transformed into chemical energy and later into mechanical energy. Each time the energy is transformed, some of it is lost in the form of heat. Thus, dissipation as heat stands at the end of all energy flows.[6]

This flow of energy and cycling of materials underscores the complexity of interrelationships existing between the components of ecosystems. It also points to the need to maintain a dynamic balance between the components of an ecosystem and between ecosystems and their environment.

One important characteristic of all ecosystems is that they are not static over time; they are continually changing and evolving. Constant adjustments occur as the ecosystem struggles to balance its surpluses in some environmental variables with its deficits in others. This "balance of nature" is often referred to as a dynamic equilibrium. This equilibrium is often characterized as the interaction of the processes of change with the processes of stability.[7]

The concept of equilibrium is of importance because humans have the potential to disrupt nature's equilibrium by creating imbalances in the system.[8] The discharge of pollutants into the air, physical transformations such as drilling, dredging, and removal of plants and animals are only a few of the ways in which humans disrupt the natural system. The ecosystem must respond to these disruptions and does so in many ways--e.g., through changes in host-predator relationships, accumulation of materials in undesirable forms, loss of water or nutrient storage capabilities, or geologic events such as erosion and earthquakes. These responses do not always occur immediately, but may take place over long periods of time. Aside from the fact that these responses are costly to deal with and affect human health, the more fundamental problem is our ability to create imbalances whose consequences we cannot always predict.

Laws Governing Energy Flows

Energy flows in human and natural systems are governed by two important and fundamental laws. These are the Law of Energy Conservation and the Law of Energy Degradation.

Law of Energy Conservation. This law is also called the First Law of Thermodynamics. According to this law, *energy can neither be created nor destroyed; it is merely transformed from one of its forms to another.* These forms are usually classified as mechanical, thermal, acoustical, chemical, electrical, and light. Transformations from one form of energy to another can alter the distribution of energy among its forms, but when all of the forms are taken into account the total amount of energy remains the same. This law seems to imply that we can never run out of energy; however, the next law is also important.

Law of Energy Degradation. This law is also called the Second Law of Thermodynamics or the Law of Entropy. The law states that *as energy is transformed* *from one form to another, some of it will be changed into a less concentrated, less useable form of energy.* Much of this degradation occurs because some of the energy that is used to do work is also transformed into heat that cannot be reused. Examples of waste heat include exhaust from automobiles and discharges from electrical production plants. Because this heat cannot be recovered into an equal amount of useable energy, it dissipates into the atmosphere heating up the earth. Thus, heat stands at the end of our one way energy flows; all other energy forms ultimately can be converted into heat, but only a limited amount of heat energy can be converted back into other energy forms.[9]

The Second Law is also referred to as the Law of Entropy. Entropy is a technical measure of the amount of disorder in a system and with respect to the Second Law is a measure of the unavailability of energy. The Second Law can be reformulated in terms of entropy: *all physical processes proceed in such a way that entropy of the universe increases.*[10] Although it would take a fairly sophisticated explanation beyond the scope of this discussion to establish the connection between order and the availability of energy, the implications of this reformulation are important to keep in mind. First, as entropy increases, more energy must be expended to maintain order. Secondly, the tendency toward entropy determines the ultimate limit of what technology can and cannot do.[11]

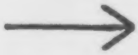
Analysis of Energy Flows

All energy flows are governed by these two laws. In order to better understand the importance of energy flows and the operation of the laws of thermodynamics, it is sometimes useful to use symbols as a means of visualizing these flows. Odum has developed a set of energy diagramming symbols based on the most common operations found in all systems that process resources and utilize energy.[12] Thus, the symbols are applicable for visualizing the interactions of both humans and natural systems with respect to energy.

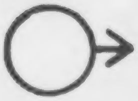
Diagramming energy flows through the use of Odum's symbols enables us to illustrate how a system and its various components interact to produce overall energy effects. We can see qualitatively where energy resources are needed, how they are being used, and where energy is being lost. If in addition we were able to attach numbers indicating the amount of energy and other resources involved, we would also be able to understand in quantitative terms how much energy costs, how efficiently it is being used, how much energy is really being yielded by a system, etc.

Through comprehensive energy flow diagramming, we would also be able to make decisions based on what is sometimes called a Third Energy Law or the "Maximum-Power Principle." This principle explains why certain systems survive: *that system survives which gets the most energy and uses energy most effectively in competition with other systems.*[13] For example, applying this principle to a particular forest, we would be able to see the kinds and numbers of trees that will take over the forest. Those that survive are those that best use the energy of the sun, the rain, and the soil to maintain forest activity.

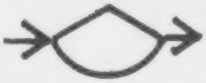
The energy diagramming symbols developed by Odum and Odum, together with descriptions of the processes they represent, are as follows:[14]



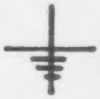
input into or output of a system (e.g., energy, food, resource)



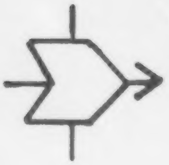
energy source from outside of the system under consideration (e.g., sun, electricity)



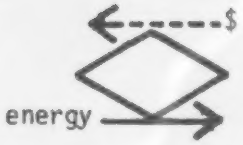
energy storage tank within the system (e.g., oil tank, hot water heater)



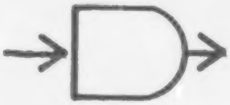
heat sink - loss of degraded energy (e.g., heat)



interaction - the interaction of two or more types of energy required for a process (e.g., sunlight and water produce food)

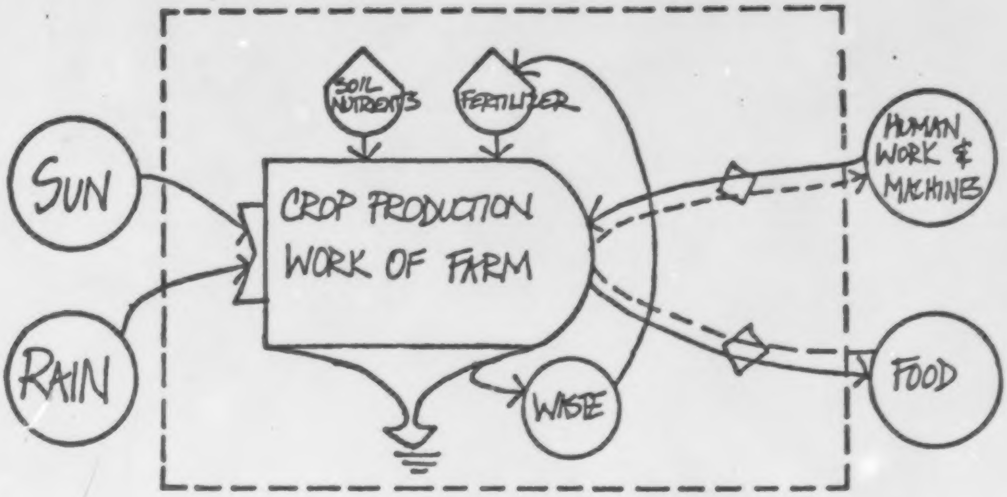


money transaction - flow of money in one direction to pay for flow of energy



production - the processes, interactions, storages, etc., involved in producing high-quality energy from a dilute source like sunlight (e.g., farm, forest, etc.)

The following example uses these symbols to show some processes and energy flows within a farm system:[15]


SOIL NUTRIENTS
FERTILIZER
SUN
RAIN
CROP PRODUCTION WORK OF FARM
HUMAN WORK & MACHINES
FOOD
WASTE

Energy input in the form of sun, rain, human work, and machinery (for planting, nurturing, harvesting, and processing the crops) flow into or enter the system. The human work and machinery are purchased. The sunlight and rain are provided free by nature. Nutrients stored in the soil and needed for crop production are also utilized by the system. The end products of crop production are the foodstuffs produced and offered for sale--part of the profits here are used to purchase more labor and machinery. Then agricultural waste materials need to be disposed of or recycled as fertilizer. A by-product of this production work is the energy lost in the form of heat at each stage of the crop production process.

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Summary

Certain fundamental principles and laws characterize all healthy, viable ecosystems. By examining these processes as they occur naturally with seemingly little human intervention, one can gain a great appreciation of their operation and function. It should be obvious, however, that these laws have implications for human activities. By understanding natural laws and the constraints they present, we should strive to design human systems that enable both the human and natural systems to exist in a harmonius and dynamic equilibrium. The way in which we deal with energy will play an important role in achieving this equilibrium.

ENERGY AND THE NATURAL SYSTEM

POOTNOTES

1. Paul R. Ehrlich, Anne H. Ehrlich and John P. Holdren, Ecoscience: Population, Resources, Environment (San Francisco: W.H. Freeman and Company, 1977), pp. 8-9.

2. Lorne H. Russwurm and Edward Sommerville, Man's Natural Environment: A Systems Approach (North Scituate, Massachusetts: Duxbury Press, 1977), p. 4.

3. "Ecosystem," McGraw-Hill Encyclopedia of Environmental Science (New York: McGraw-Hill Book Company, 1974), pp. 164-166.

4. G. Tyler Miller, Jr., Living in the Environment: Concepts, Problems and Alternatives (Belmont, California: Wadsworth Publishing Company, Inc., 1975), p. 47.

5. Miller, Jr., p. 57.

6. Miller, Jr., pp. 58-60.

7. Russwurm and Sommerville, p. 11.

8. Ehrlich, Ehrlich, and Holdren, pp. 621-705.

9. John Fowler, Energy Environment Sourcebook (Washington, D.C.: National Science Teachers Association, 1975), p. 104.

10. Elrlich, Ehrlich, and Holdren, pp. 33-35.

11. Ehrlich, Ehrlich, and Holdren, pp. 33-35.

12. Howard T. Odum, Environment, Power and Society (New York: John Wiley and Sons, Inc., 1971).

13. Howard T. Odum and Elizabeth C. Odum, Energy Basis for Man and Nature (New York: McGraw-Hill, 1976), pp. 16-23.

14. Odum and Odum, pp. 39-40.

15. This example was taken from Carol J. Murphy, Stephen R. Mills, Cathy Aaron, Kathryn O'Connell, Larry L. Peterson, and Bela H. Banathy, Energy Conserving Resource Utilization (San Francisco: Far West Laboratory for Educational Research and Development, 1978), p. 103.

ENERGY AND THE NATURAL SYSTEM

REFERENCES FOR FURTHER STUDY

Commoner, Barry. The Poverty of Power: Energy and Economic Crises. New York: Knopf, 1976.

In this volume, Commoner examines the productivity of several energy intensive industries. In doing so, he attempts to outline the conflict between the use of production systems as a means of providing maximum social benefits and their use as a means of maximizing private profits. The book contains a thorough analysis of the laws of thermodynamics.

Ehrlich, Paul R., Ehrlich, Anne H., and Holdren, John P. Ecoscience: Population, Resources, Environment. San Francisco: W.H. Freeman and Company, 1977.

This volume, containing nearly 1000 pages, provides a thorough, up-to-date perspective on the population-resource-environment predicament and discusses strategies for dealing with it. The first section, on physical and biological systems of the earth, provides basic background material on ecological and geological principles.

Fain, Theodore C., Jr., Ecological Systems and the Environment. Boston: Houghton Mifflin Company, 1976.

This text is aimed at presenting a unified framework for environmental analyses based on two tools: systems analysis and ecological concepts. The emphasis is on matters of strategy, tactics, and policy, rather than on achievements of engineering and technology. The first section on systems and ecological systems is particularly useful.

Miller, G. Tyler, Jr., Living in the Environment: Concepts, Problems, and Alternatives. Belmont, California: Wadsworth, Inc , 1975.

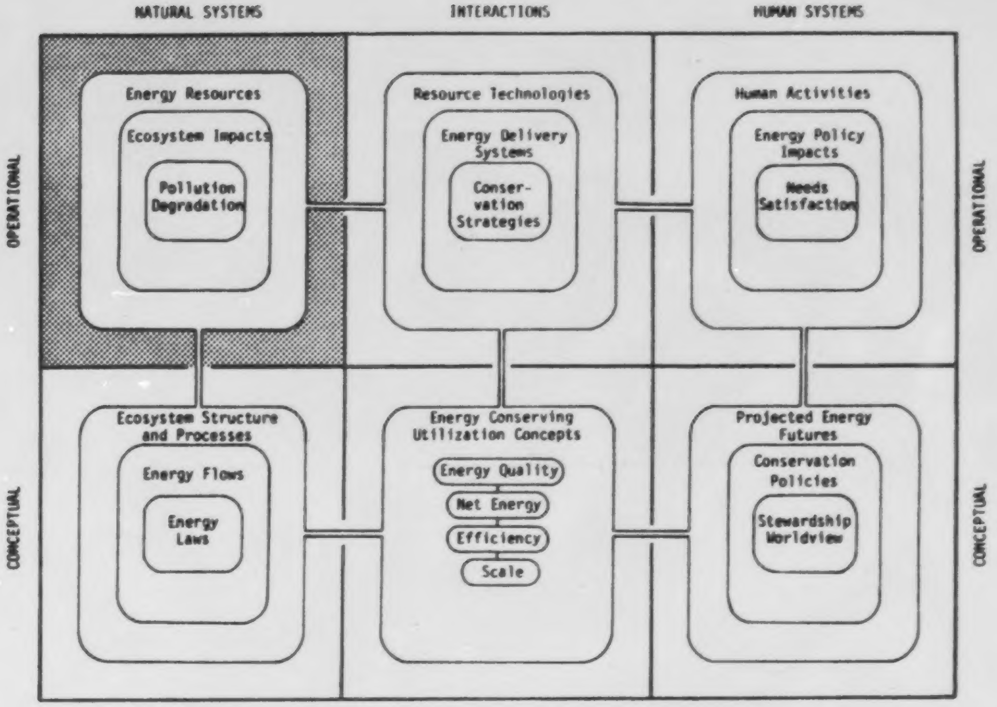
This volume is a basic text on general ecological principles and their application to major environmental problems. Five introductory chapters cover major ecological concepts. Included in the volume are twenty enrichment studies, which allow for the application of concepts to problem situations. Several of these include energy-related problems.

Odum, Howard & Odum, Elizabeth. Energy Basis for Man and Nature. New York: McGraw-Hill, 1976.

This volume provides a thorough discussion on net energy systems and energy flow diagramming. It is aimed at those who need a short, concise statement of the principles of energy and the way these shape our culture.

SECTION FOUR

NATURAL SYSTEM ENERGY RESOURCES


NATURAL SYSTEMS
INTERACTIONS
HUMAN SYSTEMS
OPERATIONAL
OPERATIONAL
CONCEPTUAL
CONCEPTUAL
Energy Resources
Ecosystem Impacts
Pollution Degradation
Resource Technologies
Energy Delivery Systems
Conser-vation Strategies
Human Activities
Energy Policy Impacts
Needs Satisfaction
Ecosystem Structure and Processes
Energy Flows
Energy Laws
Energy Conserving Utilization Concepts
Energy Quality
Net Energy
Efficiency
Scale
Projected Energy Futures
Conservation Policies
Stewardship Worldview

The Energy Conservation Curriculum Content Model Map

The content of this section, derived from the Natural Systems: Operational sector of the Model, explores the various forms of the renewable and non-renewable energy resources. The conversion of an energy resource into a useable form of energy affects environmental quality. Two general types of effects on the natural system are pollution and environmental degradation. These, of course, also have important implications for the quality of life. From a stewardship worldview, the goal of energy conservation strategies must be to nurture the natural environment. Greater energy savings are possible if we minimize negative impacts rather than trying to correct environmental assaults after they occur.

The discussion on the following pages covers the topics:

Energy Resources: Non-Renewable
Energy Resources: Renewable
Effects of Energy Utilization on the Natural System

NATURAL SYSTEM ENERGY RESOURCES

The natural system is the ultimate origin for all energy resources used by humans. In order for humans to tap the potential energy stored in a resource, complicated technological processes may be required. These technological processes impact, or effect, the quality of both human and natural system activities.

Up to the present time, decisions about the development of energy technologies have been made primarily on the basis of human systems factors (e.g., having ready supplies of relatively cheap energy available at a particular time in a particular place). Far too little attention has been given to the effect of the extraction and utilization of these energy resources and their associated technologies on the equilibrium of the natural systems.

In order to make wise energy decisions for the future, it is important to examine the nature of the primary energy resources and to understand the impact of their utilization on the natural system. In the sections that follow, the major primary energy resources first will be characterized and then attention will be focused on the effects of energy resource utilization on the natural system.

Primary Energy Resources

The primary energy resources available for use are of two basic types--non-renewable and renewable. The renewable resources exist in continuous supply, but the supply of non-renewable resources is potentially exhaustible. Certain resources such as fossil fuels are termed non-renewable even though they are derived from continuing biological processes--their rate of renewal relative to the demand for these resources, is so slow that the available supply could be depleted.

Table 1 classifies the major primary resources according to their renewability. The resources listed are called primary because they drive the production and delivery of energy. Secondary or tertiary energy resources are energies recycled from processes driven by a primary resource. For example, steam usually discarded as waste heat from a power plant can be re-used. Although it is not hot enough to drive turbines, it is hot enough to heat surrounding buildings. This process of using waste heat is also called co-generation. Through co-generation, we have a potential important secondary energy resource that so far has been little used in this country.

Table 1

PRIMARY ENERGY RESOURCES	
NON-RENEWABLE	RENEWABLE
Fossil Fuels	Solar
coal	Fresh water
tar sands	Oceanographic
petroleum	tidal
natural gas	temperature gradient
oil shale	Geothermal
lignite	steam
Nuclear	heat
fissionable materials	Wind
fussionable materials	Bio Mass

The non-renewable energy resources are sometimes popularly termed conventional resources. Those that are renewable (with the possible exception of fresh water hydroelectricity) are often referred to as "alternative" or "non-conventional" resources. Much has been written about conventional as well as non-conventional energy resources and their associated technologies. The paragraphs that follow briefly describe these resources. More elaborate descriptions of these energy resources and technologies can be found in the references at the end of this section.

Fossil Fuels. The fossil fuels include the family of hydrocarbons classified as petroleum, natural gas, coal, tar sands, etc. The various fossil fuels require different processes for conversion into usable energy forms.

By almost any method of analysis, U.S. and world supplies of petroleum and natural gas are small in relation to projected demands. Estimates of coal reserves are much larger; but, they, too, are finite![1] Yet, these energy resources provide about 93% of the energy currently used in the United States.[2]

Because of the finiteness of the supply of fossil fuel, an increased emphasis is now being placed on improving the technology for harvesting fossil fuels. Processes are being or have been developed to liquify natural gas, to create synthetic fuels from coal, and to utilize the hydrocarbons in oil shale and tar sands. Although these efforts may, in effect, increase our available reserves of fossil fuels, they can only delay the time when these supplies will be exhausted.

In addition to the finiteness of supply and the danger that we are rapidly using up our reserves, other factors suggest that we decrease our dependence on fossil fuels. Because the extraction and conversion of fossil fuels involves highly sophisticated technology, a large investment of capital and energy is required to produce a useable fuel. So we have to expend a great amount of energy simply to get more energy. And future supplies will become increasingly more expensive. Furthermore, fossil fuels are location specific. Thus, their availability may be controlled by political factors. The "oil embargo" and Iranian crises of the 1970's are examples of this.

Nuclear Energy. An alternative non-renewable, but seemingly inexhaustible energy source is nuclear power. There are two distinct nuclear power processes: nuclear fission and fusion. Both processes require complex technology, and large amounts of capital investment and energy. Nuclear energy is also the most controversial energy resource due to questions of radiation effects, waste disposal, etc.

The process of releasing energy by splitting heavy atoms of materials such as uranium is known as fission. An enormous amount of energy is generated in the fission process; in one fission event, many more times as much energy is released as in the burning of a carbon atom in a form such as coal.

One of the technical problems associated with most current nuclear power plants is their relative inefficiency. Most of today's reactors are able to release only 1 or 2% of the energy potentially available from the uranium used in the process.[3] Thus, in effect, it consumes more fuel that it produces. This is not a problem as long as uranium is in plentiful supply and cheap. But, like fossil fuels, a finite quantity exists; it may not always be cheap or readily available. As a result, attention has been placed on developing a different type of nuclear reactor. This is the nuclear breeder reactor. The breeder creates additional fuel as it produces heat for electricity.

The process of releasing energy by the combination of very light atoms is known as fusion. The fusion process is the same as that used in the sun and stars.

> This process involves compressing a thin, ionized gas composed of hydrogen-heavy atoms and heating it to a temperature higher than the interior of the sun, until the atoms collide with such impact that they fuse and release nuclear energy.[4]

Currently, the major obstacle to developing the nuclear fusion process is the lack of a suitable container for materials that reach a temperature of 180 million degrees, heat so great that it melts any known substance.

Solar Energy. A vast amount of sunlight falls on the earth each day. Areas of the country that have fairly high average sunlight levels could utilize this energy from the sun to heat and to cool buildings. Solar energy can be collected, stored, and circulated through a building directly if the structure has been designed for this purpose. It can also be utilized indirectly through special solar energy hardware. At the present time this method of heating and cooling through the use of solar energy is practical only on a small scale.

Larger scale uses of solar energy may be possible through the development of photovataic, or solar, cells. The cells can be used to produce electricity. Currently, these solar cells are the predominant source of power for space satellites. Solar cells have no moving parts, consume no fuel, produce no pollution and can be made from silicon, the earth's second most abundant element. Thus far, high costs have been a principal deterrent to their use.

Fresh Water. Any fast moving or falling water source can be tapped for energy, principally to produce electricity. At the present time, hydro(water) power accounts for about 15% of the electricity supply for the United States.[5] Thus, it cannot properly be called an alternative or non-conventional energy source. Although hydroelectric power offers potential for developing nations for use as an energy resource, the United States may already be currently utilizing the power source to near its maximum potential.

Oceanographic Resources. Ocean water can provide another source for power generation. Electricity can be generated from temperature gradients (or differences) in oceans. The temperature gradients between the cold water in ocean currents and the warm water that surrounds it is enough in some waters to power a submerged generator.

Ocean tides are also potential energy resources. The gravitational pull of the sun and the moon controls the massive and regular ebb and flow of billions of gallons of water. This tidal motion can be used to produce electricity.

The technologies required to utilize oceanographic energy are not well developed. Moreover, their use would probably be limited to only certain areas of the world.

Geothermal. As the name implies, geothermal energy is the natural heat of the earth. The source of this heat is the molten center of the earth, where temperatures are in excess of 1,000°C. Only certain areas of the country have the underground conditions that allow this heat to come to the surface of the earth in one of the following forms: hot dry steam, wet steam and hot water, and hot dry rocks.

The wet steam and hot water that escapes from the earth can be utilized to heat homes. Certain Scandanavian countries make wide use of this wet steam and hot water to do so. Dry steam, on the other hand, can be piped to steam turbines and used to generate electricity.

Wind. Technically, wind could be considered a form of solar energy because the energy of the wind originates in the sun. Utilization of wind power requires a wind mill. The technology of wind mills is well developed, as is the aerodynamic theory on which they are based.[6]

One of the disadvantages of wind power is the intermittent and unreliable nature of its geographical limitation. Thus, storage of wind power has been one of the major obstacles to its effective use.

Biomass. Technically, biomass is the total weight, or mass, of all living things in an area.[7] When used as an energy resource term, biomass refers to the use of living or once living organisms to produce energy. *Energy crops* and *organic wastes* are the two general classifications of biomass resources.

Energy crops are crops cultivated specifically for their energy value. The most common energy crops are trees. The supply of trees is limited even though renewable. Other crops such as corn and sugar cane can be converted to alcohol and other useable fuels.

Organic wastes can also be used as an energy resource. Urban garbage and other waste products such as manure can be burned to produce electricity. In addition, the methane gas that naturally develops from the fermentation of organic wastes can be trapped. Other gases or liquid fuels can also be converted from waste products. The major drawback to most bioconversion processes is that very large amounts of waste materials are needed to produce significant yields of energy.

Effects of Energy Resource Utilization on Natural Systems

Utilizing any of the primary energy resources impacts upon the natural system. No energy resource, even solar, is free of potential negative effects on the environment.[8] These effects should be examined systematically so that from a conservation standpoint, we can utilize energy resources in the future that are least disruptive of the equilibrium of the natural system but at the same time are capable of meeting human needs. Generally speaking, impacts on the natural system can be classified into two major categories: pollution and environmental degradation.

Pollution. As an energy resource is converted and utilized, two by-products are usually produced in addition to the released energy--waste products and heat.

The most obvious examples of waste products are the gases and particulate matter resulting from the conversion of fossil fuels. For example, a typical coal-fired electric power plant producing one million kilowatts of power also produces in excess of 300 tons of coal, 940 tons of carbon dioxide, 13 tons of ash.[9] Although much of this is trapped, even a small percentage escaping is significant.

In short, millions of tons of pollutants are dumped annually into the atmosphere from all sources, such as industrial plants and automobiles. These waste products create an unpleasing environment in which to live and can cause physical discomforts and ailments. They also contribute to a vicious cycle: more energy must be expended to deal with the waste products.

Heat is also a by-product of energy conversion. Most of this heat is released into the atmosphere or into water. When the heat is expelled in water, temperatures are raised beyond the normal range, endangering the equilibrium of the under water systems. For example, it has been estimated that by the year 2000, the amount of heat emanating from all U.S. power plant, regardless of type, would be enough to raise the temperature of this country's annual rain runoff by 20°F.[10] Among other things, this may endanger fish in streams.

The long-term effects of pollution are also of concern. No one knows for sure what impact large amounts of waste heat will have on climates. Temperatures may rise as a result of increased amounts of carbon dioxide in the atmosphere. Particulate buildup also increases solar refraction, which interferes with the photosynthesis process of plants.

Environmental Degradation. The destruction of the physical environment is also an important natural systems factor to consider in evaluating the potential of energy resources. For example, destruction of soils and natural terrain results from the strip mining of coal. Although it is possible to rebuild the environment, the long-term impact that this destruction will have on the ecology of the natural system is not at all clear.

There are also potential environmental dangers related to each energy resource that must be taken into consideration. Oil spills or nuclear radiation leaks are potentially destructive to the environment, as evidenced by the recent unfortunate incident on Three Mile Island in Pennsylvania. In areas of the country susceptible to earthquakes, attention must be given to the placement of dams for hydroelectric production. As is the case with pollution, energy is required to remedy environmental degradation.

Summary

There are a number of primary energy resources available in natural systems. Pollution or environmental degradation risks are associated with each of the primary renewable or non-renewable resources; these risks must be taken into consideration when deciding which resources to use. Many of the potential problems may be subject to technological solutions; these technological solutions also require energy. From the standpoint of energy conservation in developing

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energy resources for the future, it is desirable to select those resources which have the fewest negative impacts on the natural system, while at the same time are capable of meeting human needs.

NATURAL SYSTEM ENERGY RESOURCES

FOOTNOTES

1. Paul R. Ehrlich, Anne H. Ehrlich, and John P. Holdren, Eco Science: Population, Resources, Environment (San Francisco: W.H. Freeman and Sons, 1977), pp. 400-411.

2. U.S. Department of Energy, Energy In Focus: Basic Data (Washington, DC: U.S. Department of Energy, January, 1978), p. 2.

3. Carol Steinhart and John Steinhart, Energy: Sources, Use and Role in Human Affairs (North Scituate, MA: Duxbury Press, 1974), p. 136.

4. Ned Greenwood and J.M.B. Edwards, Human Environments and Natural Systems (North Scituate, MA: Duxbury Press, 1973), p. 87.

5. Steinhart and Steinhart, p. 169.

6. Steinhart and Steinhart, p. 163.

7. Steinhart and Steinhart, p. 343.

8. The negative impacts of energy resource technologies involving the fossil fuels are well documented. The possible negative impacts of non-conventional resource technologies are just beginning to be studied. See, for example, "Hazards of Solar Energy," People and Energy, IV (November/December, 1978), pp. 5-6.

9. Steinhart and Steinhart, p. 123.

10. Greenwood and Edwards, p. 81.

NATURAL SYSTEM ENERGY RESOURCES

REFERENCES FOR FURTHER STUDY

Clark, Wilson. Energy for Survival. Garden City, New York: Anchor Books. 1974.

This volume presents the case for developing energy alternatives through intermediate technology. It is particularly valuable for its discussion of the environmental impact of the use of various resources.

Ehrlich, Paul R., Ehrlich, Anne H., and Holdren, J. P. Ecoscience: Population, Resources, and Environment. San Francisco: W. H. Freeman and Company, 1977.

This volume, containing nearly 1000 pages, provides a thorough, up-to-date perspective on the population-resource-environment predicament and discusses strategies for dealing with it. Section III is particularly relevant as it deals with energy and materials. Section II, which discusses population and renewable resources, is also of interest.

Fain, Theodore C., Jr. Ecological Systems and the Environment. Boston: Houghton Mifflin Company, 1976.

This text is aimed at presenting a unified framework for environmental analyses based on two tools: systems analysis and ecological concepts. Section C on matching resources and future needs is particularly relevant for its discussion of the impact of growth on systems.

Scientific American. Energy and Power. San Francisco: W. H. Freeman and Company, 1971.

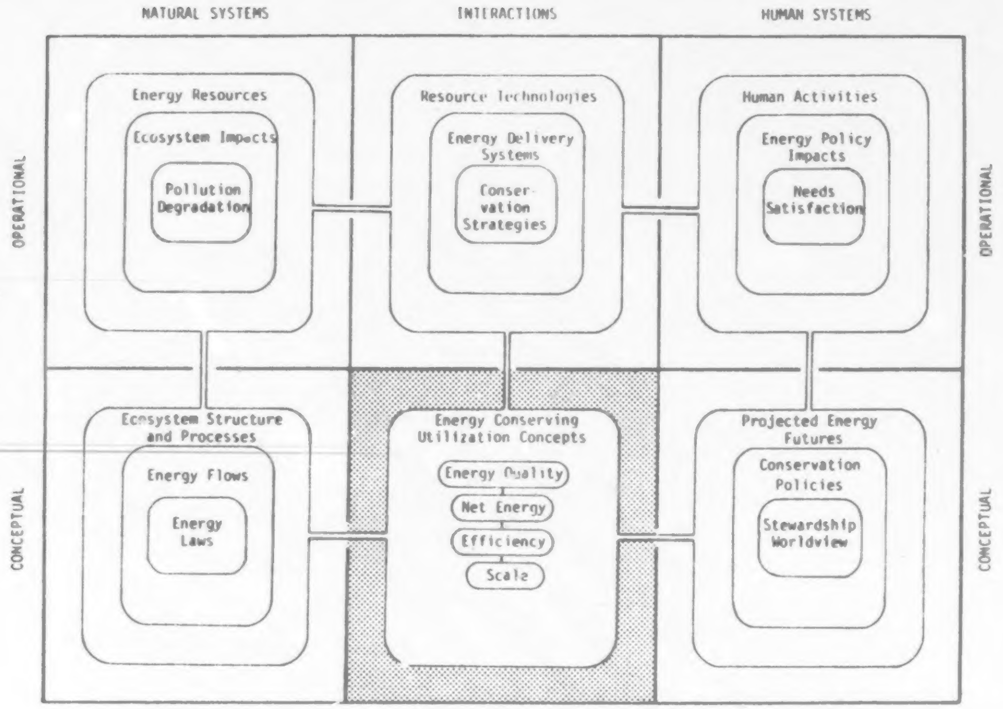
The eleven chapters in this book originally appeared as articles in Scientific American. M. King Hubert's chapter on the energy resources of the earth places each in a historical perspective.

Steinhart, Carol E. and Steinhart, John. Energy: Sources, Uses, and Role in Human Affairs. North Scituate, Mass.: Duxbury Press, 1974.

This volume provides a broad introduction to energy concepts and energy resources. In a simplified, yet technical fashion, the authors attempt to be as comprehensive as possible in discussing the present as well as the future energy prospects.

SECTION FIVE

ENERGY CONSERVING UTILIZATION CONCEPTS


NATURAL SYSTEMS
INTERACTIONS
HUMAN SYSTEMS
OPERATIONAL
OPERATIONAL
Energy Resources
Ecosystem Impacts
Pollution Degradation
Resource Technologies
Energy Delivery Systems
Conservation Strategies
Human Activities
Energy Policy Impacts
Needs Satisfaction
CONCEPTUAL
CONCEPTUAL
Ecosystem Structure and Processes
Energy Flows
Energy Laws
Energy Conserving Utilization Concepts
Energy Quality
Net Energy
Efficiency
Scale
Projected Energy Futures
Conservation Policies
Stewardship Worldview

The Energy Conservation Curriculum Content Model Map

The content in this section, derived from the Interactions: Conceptual sector of the Model, focuses on concepts relevant to assessing the conservation potential of energy producing and utilizing technologies. Among these concepts are the energy quality, net energy, efficiency, and scale. These concepts are also useful in assessing the appropriateness of our technologies to meet our end use needs.

The discussion on the following pages covers the topics:

Energy Quality and End Use
Net Energy
Efficiency
Scale

ENERGY CONSERVING UTILIZATION CONCEPTS

To develop and utilize energy requires the application of technology. Although our technology must take into account the major laws and principles that govern energy flows, we do have considerable flexibility with respect to the specific type of energy technology systems we use to satisfy our needs. Several concepts are relevant to assessing the energy conservation potential of our current and projected energy technologies. These concepts include energy quality and end use, net energy, efficiency, and scale.

Application of these concepts should help us to select the most appropriate, energy-conserving technologies to meet our needs. It is likely that in so doing, we will not select just one technology but will instead utilize a mix of energy technologies, each one designed for what it does best in a particular set of circumstances.

Energy Quality and End Use

Energy quality is a measure of potential to do work. Some forms of energy have a greater potential than others to do work. For example, electricity is a high quality form of energy. Its quality resides in the fact that it has been concentrated from lower quality energy resources such as coal and as a result is very flexible. It can be used to operate highly complex machines, to light homes, and to operate electric tooth brushes. On the other hand, sunlight is a dilute lower quality energy resource; a unit of sunlight cannot be used in the same way for as many different purposes as a unit of electricity.[1]

A great deal of energy is required to produce high quality energy. For example, approximately four calories of coal must be utilized to produce one calorie of electricity.[2] And at each step in this conversion process, considerable energy is lost as waste heat.

In terms of energy costs, then, high quality forms of energy are expensive products. They therefore should be used to meet only high quality energy end use requirements. Energy can be saved if we attempt to match energy quality and end use needs (e.g., home heating, lighting, etc.).

For example, in the United States today, we consume about 29% of our fossil fuels to generate electricity to meet about 13% of our end use needs; however, only about 8% of these end use needs really require such a high quality form of energy.[3] That is, uses such as lighting or telecommunications require electricity, while low temperature heating and cooling do not. If we were to generate only the electricity that is required for its end use and avoid using it for applications that can operate on lower-quality energy, we have the potential for a sizeable conservation of our energy resources. According to Lovins,

> Where we want only to create temperature differences of tens of degrees, we should meet the need with sources whose potential is tens or hundreds of degrees, not with a flame temperature of thousands or a nuclear reaction temperature equivalent to trillions - like cutting butter with a chainsaw.[4]

Net Energy

The concept of net energy relates to the true value of an energy source after all energy costs have been subtracted. The potential energy content of an energy resource as it exists before going through any attempt to transform it into a useable form of energy is its gross energy value. This amount of energy is very different from that remaining after all of the energy costs to transform it have been paid. The concept of net energy therefore enables one to analyze in terms of energy the amount of the energy resource remaining after all of the "costs" to make it have been paid in energy equivalents.[5]

In terms of energy conservation the concept of net energy enables us to assess the true value of any energy resource. For instance, our oceanographic oil reserves may appear large. When one considers all of the energy costs to tap and utilize these reserves (such as building steel towers, operating pipelines and boats, repairing corrosion and damage from storms, and operating a complex service system), the net energy yielded may be very low.[6] In conserving energy or using energy wisely we must attempt to meet energy needs with only those resources which yield the most net energy.

Efficiency

Most discussions of energy conservation concentrate on strategies for improving energy efficiency. The rationale for improving energy efficiency is that saving a unit of energy generally costs less than producing the same amount of energy from a new resource.[7] When applied to energy use, the term efficiency, as commonly used, has some reference to a comparison between the total energy (or work) output of a process and the total energy input. A technological process is said to be highly efficient when little energy is wasted; conversely, processes resulting in a great deal of wasted energy are highly inefficient.

In this sense, efficiency is usually defined in the following way:[8]

$$\%\text{ Efficiency} = \frac{\text{amount of energy or work delivered in form and place desired}}{\text{amount of energy required to achieve the desired impact}} \times 100$$

This definition of efficiency, involving only amounts of energy, is more appropriately called the "first law efficiency" because of its relationship to the first law of thermodynamics. According to the first law, all of the energy in a system must be accounted for; therefore, if 60% of the energy in a process from input to useful end use results in useful works, the remaining 40% is called wasted energy.

The term "wasted energy" is, however, ambiguous. In any process, some energy is wasted because of imperfections in the technologies used; but some of the loss represents the amount that, according to the second law of thermodynamics, could not have been avoided even with a perfect technology.[9] Remember that the second law states that as energy is converted in any process, some of it is degraded in quality and loses its ability to do work.

There is, then, a second law efficiency which measures "by how much" the performance of a process falls short of what is theoretically possible. The second law efficiency is defined as[10]

$$\%\ \text{Efficiency} = \frac{\begin{array}{l}\text{minimum amount of available energy to do}\\ \text{work needed to perform a desired function}\end{array}}{\begin{array}{l}\text{actual amount of available energy used to}\\ \text{perform the function}\end{array}} \times 100$$

Ehrlich, Ehrlich, and Holdren have provided an example that clarifies the distinction between the first and second laws of efficiency.[11] In a given temperature condition, an ordinary home furnace may deliver 1 unit of heat energy for every 1.5 units of energy extracted from its fuel. Its first law efficiency would therefore be 67% (1 unit/1.5 units). Applying the second law and understanding that a heat pump can ideally deliver 1 unit of heat for only .07 units of energy results in a second law efficiency of only 4.7% (.07 units/1.5 units). According to the second law, there is then a great potential for improvement by designing and implementing alternatives to our current home heating technologies.

The second law is, therefore, a measure of how much technological performance can theoretically be improved; a low efficiency means that there is much potential for improvement. The first law efficiency simply suggests that by proper design and maintainance, the operating efficiency of nearly everything could be improved. On the other hand, the low second law efficiencies for most of our current technologies imply that it would be worthwhile to investigate alternative technologies which may produce similar output with less energy use.

Whether based on first or second law efficiency definitions, most studies of energy efficiency in the United States indicate that many of our current technological practices are not efficient. Indeed, a recent article in *Business Week* estimated that the overall energy efficiency of the U.S. economy is 10% or less.[12] More conservative estimates indicate that the same mix of goods and services could have been provided to the U.S. population in the early 1970's using only 60% of the energy actually used.[13] Thus, improving the efficiency of our current energy production and usage systems should enable us to do more without a corresponding increase in energy demands.

Scale and End Use

Concepts of *scale* are also useful in evaluating the conservation potential of energy technologies.[14] Most of our current energy production activities are based on centralized, large scale systems. That is, we build large electrical production plants based on the belief that this is the most efficient and economical way to deliver electricity to the consumer. There is some evidence that building increasingly large scale energy production technologies (as are currently being planned in many uses) may not be the most effective way to meet all of our energy needs, and that smaller or medium-sized scale technologies may better meet our needs in a more cost effective and energy efficient way.[15]

For example, a great deal of capital investment is required to develop large scale energy production and distribution facilities. A great deal of energy also must be expended to develop and to maintain the system. Additional energy and dollar costs are incurred in the large storage, transportation, and distribution systems required for getting the energy to the users. In the case of electricity, these include transmission lines, cables, meter readers, planners, advertising agencies, etc. These costs must be reflected in the price to the consumer. Indeed in large scale production of electricity, distribution overhead costs account for half of the electricity bill.[16]

Finally, and perhaps most importantly, when large numbers of users depend on a centralized source of electricity or other forms of energy, any breakdown has a number of immediate and sometimes severe impacts. The New York City blackouts are an example of this. To avoid these impacts, centralized systems need to maintain large reserve or alternative systems which may be used only a few times. These, too, cost money and energy.

Issues concerning scale and its merits are just now becoming a subject for scrutiny. Undoubtedly, certain large scale energy technologies are required. But, like energy quality, complexity of scale should be appropriate for end use so that the end use needs are the prime consideration rather than needs of the energy source controlling the end use.[17]

Summary

Several important concepts should be used to assess our current energy technologies and systems. An application of these concepts to various energy technologies should enable one to arrive at some "tentative" judgments concerning the viability of each technology for meeting human needs. These concepts must be used, however, in conjunction with our concerns for the health of natural and human systems.

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ENERGY CONSERVING UTILIZATION CONCEPTS

FOOTNOTES

1. Howard Odum and Elizabeth Odum, *Energy Basis for Man and Nature* (New York: McGraw-Hill, 1976), pp. 32-33.

2. Odum and Odum, p. 33.

3. Amory Lovins, *Soft Energy Paths: Toward A More Desirable Peace* (San Francisco: Friends of the Earth International, 1976), p. 39.

4. Lovins, p. 40.

5. Odum and Odum, pp. 79-80.

6. Odum and Odum, p. 81.

7. California Energy Commission, 1977 *Biennial Report*, Vol. 3., Opportunities For Energy Conservation (Sacramento: State of California Energy Commission, 1977).

8. Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, Environment*. (San Francisco: W.H. Freeman and Company, 1977), p. 398.

9. Ehrlich, Ehrlich, and Holdren, p. 398.

10. Ehrlich, Ehrlich, and Holdren, p. 398.

11. Ehrlich, Ehrlich, and Holdren, p. 399.

12. *Business Week*, April 15, 1977.

13. Ehrlich, Ehrlich, and Holdren, p. 491.

14. Lovins, pp. 39-41.

15. Lovins, p. 42.

16. Lovins, p. 40.

17. Lovins, pp. 25-60.

ENERGY CONSERVING UTILIZATION CONCEPTS

REFERENCES FOR FURTHER STUDY

Lovins, Amory. Soft Energy Paths: Toward a More Durable Peace. San Francisco: Friends of the Earth, 1977.

Science magazine has called this volume "easily the most comprehensive and technically sophisticated attempt to put together an energy program compatible with environmental values." Written in semi-technical language for the lay reader, Lovins describes and contrasts "hard" and "soft" energy paths and suggests that alternative technologies can better meet our end use needs. It contains excellent discussions of the various energy resource utilization concepts.

Fowler, John. Energy-Environment Source Book (Volumes I and II). Washington, D.C.: National Science Teachers Association, 1975.

These two volumes provide a wealth of energy information and data at all levels: technical, economic, political, societal, and environmental. The volume contains a good description of energy efficiency.

Gilliland, Martha W. (ed.). Energy Analysis: A new Public Policy Tool. Washington, D.C.: American Association for the Advancement of Science, 1978.

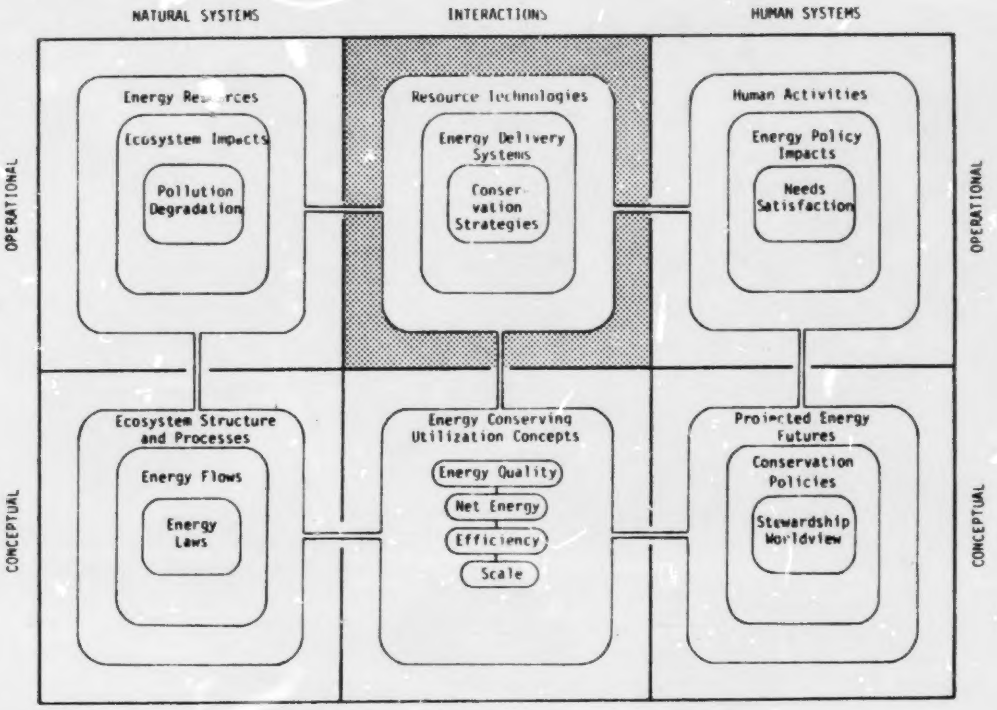
This volume is a compilation of papers presented at an American Association for the Advancement of Science symposium. Together, they outline several different points of view regarding methods for energy analysis and the kinds of policy questions that can be answered by this process. Gilliland's first chapter describes opportunities for increasing net energy through increasing efficiency.

Odum, Howard and Odum, Elizabeth. Energy Basis for Man and Nature. New York: McGraw Hill, 1976.

This volume provides a thorough discussion of the concept of net energy and net energy analysis.

SECTION SIX

ENERGY DELIVERY SYSTEMS


NATURAL SYSTEMS
INTERACTIONS
HUMAN SYSTEMS
OPERATIONAL
CONCEPTUAL
OPERATIONAL
CONCEPTUAL
Energy Resources
Ecosystem Impacts
Pollution Degradation
Resource Technologies
Energy Delivery Systems
Conservation Strategies
Human Activities
Energy Policy Impacts
Needs Satisfaction
Ecosystem Structure and Processes
Energy Flows
Energy Laws
Energy Conserving Utilization Concepts
Energy Quality
Net Energy
Efficiency
Scale
Projected Energy Futures
Conservation Policies
Stewardship Worldview

The Energy Conservation Curriculum Content Model Map

The content in this section, derived from the Interactions: Operational sector of the Model, describes a systematic framework for understanding energy technologies from their exploration to end use. These energy technologies, providing the basis for the interaction between human and natural systems, can be systematically compared through a detailed specification of the delivery system associated with each of the various energy resources. The energy components of all technologies can be examined systemically using a similar framework. Specific conservation strategies can then be developed based on this analysis of the total system.

The discussion on the following pages covers the topics:

The Stages in Energy Delivery Systems
Energy Conservation Strategies

ENERGY DELIVERY SYSTEMS

The utility of concepts such as net energy, energy quality, scale, and efficiency becomes more apparent when used in an analysis of an entire energy system of resource production from its exploration to end use. Looking at the entire system, for example, enables one to trace the total flow of energy in a system, and to examine the resources and technologies required. One important objective for such a systemic analysis is, of course, to pinpoint areas where energy resources and technologies can be used wisely and can be conserved.

Analyzing Energy Delivery Systems

One way to make sure a total resource system is examined is by using the concept of a delivery system. A delivery system is defined here as the steps or processes required to change a raw resource into useful work.[1] When energy is the resource, the sequence of steps, or path, by which energy finds its way from origin to application to disposal is sometimes also called a fuel cycle (although no real cycling is involved).[2] For example, the conversion of crude oil to electricity for consumer use usually requires the following sequence of activities, which together constitute its delivery system.

EXPLORATION: geologic exploration for oil
EXTRACTION: tapping oil well
TRANSPORT I: shipping crude oil to refinery
PROCESSING: processing crude oil at refinery
STORAGE: storage of crude and refined petroleum at refinery
TRANSPORT II: shipping to electrical production facility
CONVERSION: transforming into electricity

DISTRIBUTION: distribution of electricity to consumer

END USE: operating electrical appliances

Most of our current energy resource technologies involve a sequence of activities similar to those in the above petroleum example. Table 1 characterizes, in more general terms, typical delivery system stages and the activities associated with each of these stages.[3]

Table 1

ENERGY DELIVERY STAGES

STAGE	ACTIVITY
EXPLORATION:	siting of resource deposits, basic research and development techniques
EXTRACTION:	removing the resources, building and maintaining the site
PROCESSING:	concentrating (crushing, sorting) and refining (cleaning) the resource
TRANSPORT:*	moving the resource from one site to another
STORAGE:*	maintaining resource in a storage facility
CONVERSION:	changing form of energy in a boiler, furnace, etc. facility; building costs are included
DISTRIBUTION:*	moving converted form of energy from its final facility to consumer; advertising, bookkeeping, marketing
END USE:	input into basic human needs; heating, cooling, moving vehicles, etc.

*May occur more than once.

Every energy delivery system does not include all of these stages. Most conventional technologies (such as petroleum and nuclear energy production) do have all of these stages; indeed, several cycles of processing, transportation, and storage may be required. On the other hand, the less conventional technologies such as passive solar and wind frequently, but do not necessarily have fewer stages.

The energy delivery example described above (conversion of petroleum to electricity) was presented for purposes of illustration in fairly simplistic terms. It is possible, through the use of the many literature resources available to us, to characterize more elaborately and accurately the processes involved at each stage in the delivery system. Indeed, it could be an instructive (though complex) task to construct a chart detailing the delivery stages and required technologies for the various primary energy resources, including all of the varieties of fossil fuel resources, nuclear, and nonconventional resources. Through such a tool we could gain a better understanding of the nature of these energy resources, the number of stages required, and where, when, and what types of technologies are involved. The following figure presents a simplified version of an incomplete delivery system chart:

	TECHNOLOGIES REQUIRED DELIVERY STAGE			
ENERGY RESOURCE	Exploration	Extraction	Transport	(Remaining Stages)*
Petroleum				
Natural Gas				
LNG				
Nuclear				
Solar				
(Remaining Resources)*				

*In a completed chart, the remaining additional delivery stages and energy resources would be included.

This elaboration provides the basis for applying, at least conceptually, several of the major resource conserving concepts described in Section Five. For example, with increases in the number of stages, there is increased opportunity for heat loss and inefficiency. Increased complexity of technological scale may also be required. There is also the potential for low net energy. By detailing the major end uses, we could determine if the high quality form of energy that usually results as the number of stages increases is required. In addition, we could examine where and when possible environmental consequences might occur. In applying these concepts, our goal is, of course, to select those resources and technologies that are appropriate for their end use and that minimize their negative impact while providing the greatest benefit to both the natural and human systems. This is perhaps the essence of what constitutes appropriate technology.

Strategies to Increase Better Energy Use

The analytical framework described above provides a systemic, but conceptual basis for comparing various energy technologies. Similar comprehensive, analytical frameworks, which examine the whole system and not just single stages, can be developed and used to determine the energy requirements for all of our major technologies. For example, in the automotive industry, the major stages might include design, manufacture, distribution, sales, maintenance, and end use. Out of these analyses of entire systems, we can trace how we are using energy in our technological society. By applying concepts such as energy quality, scale, efficiency, and net energy, we can assess how appropriately and wisely we are using our energy resources. Specific strategies can then be devised and implemented to prevent energy waste and to better use our energy resources.

There are, of course, many steps that can be taken individually and collectively to save our current energy resources and to make better use of future resources. Some of these affect our direct uses of energy (lowering the thermostat); while others affect our indirect uses of energy (buying more durable clothing of natural fabrics). Indeed, there are so many specific things that can be done that it is useful to categorize the major types of strategies that can be implemented. Lee Schipper has done so and his classification is as follows:[4]

> Leak plugging: Heat and cooling losses can be prevented in most systems; improvements and corrections can be made in currently designed energy systems. Examples are building insulation, improved maintenance, and heat recovery. through cogeneration.
>
> Mode Mixing: The mix of transportation modes can be changed to require less energy per passenger or ton-mile.
>
> Thrifty Technology: New technology can be introduced in any energy system which increases the useful output per unit of energy consumed. Heat pumps are an example.
>
> Input Juggling: The mix of economic or physical inputs can be changed for a given output. Recycling is an example, as is substituting increased human labor for machines.
>
> Output Juggling: Changes can be made in life styles, consumer preferences, investment practices, or shifts from manufacturing to services in the economy that lead to lowered energy requirements. Examples are smaller cars and changing housing patterns.
>
> Belt Tightening. Small but important changes can take place that may cause minor inconveniences or changes in habits, but which result in reduced use of energy. Examples include turning off lights, lowering thermostat settings, or driving more slowly.
>
> Curtailment. Particular activities may be curtailed or banned, such as driving bans or factory shutdowns.

There are, therefore, a wide variety of strategies that can be pursued to save energy. These should be applied to all stages in a delivery system. Numerous studies in which these strategies have been pursued have indicated that the potential is great for using our currently available energy resources more wisely.[5] Additionally, there are numerous publications available from utilities, the U.S. Department of Energy, public interest groups, and other agencies that provide information on techniques to save energy at home, in transportation areas, and on the job.[6] These strategies should not, however, be implemented in a piecemeal fashion whereby energy saved in one area results in wasted energy in another. To effectively conserve energy we must consider the entire system.

Summary

To fully understand the potential for energy conservation requires an analysis of energy delivery systems. These systems include those that make energy available to us and those that create the goods and services we use. A wide variety of energy saving strategies can be developed using the context of a delivery system to ensure that we use energy more efficiently and wisely.

ENERGY DELIVERY SYSTEMS

FOOTNOTES

1. Office of Energy Research and Planning, Office of the Governor, State of Oregon, *Transition: A Report to the Oregon Energy Council* (Portland, Oregon: Prometheus Unbound Speciality Books, 1977), Appendix A.

2. Paul Ehrlich, Anne Ehrlich, and John Holdren, *Ecoscience: Population, Resources, Environment* (San Francisco: W.A. Freeman and Company, 1977), p. 411.

3. These stages are a synthesis and combination of those developed in the Office of Energy Research and Planning Report and in Ehrlich, Ehrlich, and Holdren.

4. Lee Schipper, "Energy Conservation: Its Nature, Hidden Benefits and Hidden Barriers," *Energy Communications*, Volume 2, No. 4, 1976.

5. See, for example, discussions and references contained in Ehrlich, Ehrlich, and Holdren; and in Schipper.

6. See Section III of the Energy Conservation Resource Bibliography in Part Two for sources of relevant information.

ENERGY DELIVERY SYSTEMS

REFERENCES FOR FURTHER STUDY

Abelson, Philip (ed.) Energy Use, Conservation and Supply. Washington, D.C.: Association for the Advancement of Science, 1974.

This is an excellent compilation of articles from Science magazine on energy supply and alternative systems. Also included are discussions on food production, people, and institutions.

Fowler, John. Energy-Environment Source Book (Volumes I and II). Washington, D.C.: National Science Teachers Association, 1975.

These two volumes provide a wealth of information and data related to energy issues. Volume I deals with economic, political, societal, and environmental issues related to energy production and consumption. Volume II provides the scientific and technical background that is needed for a thorough understanding of Volume I. Sufficient information and data is provided in the two volumes to give some understanding of total energy delivery costs in various systems.

Merrill, Richard and Gage, Thomas (eds.) Energy Primer: Solar, Water, Wind, and Biofuels. New York: Delta Books, 1978.

This book is a revision of a volume produced in 1974 by the Portola Institute, publisher of the Whole Earth Catalog. It is a fairly technical but highly readable book about renewable forms of energy and small scale systems. A great deal of attention has been given to providing reviews of books and hardware sources.

Odum, Howard and Odum, Elizabeth. Energy Basis for Man and Nature. New York: McGraw-Hill, 1976.

This volume provides a thorough discussion of net energy and energy flow diagramming. Through the tool of energy diagramming, one can trace energy flows through various delivery systems.

Office of Energy Research and Planning. Transition: A Report to the Oregon Energy Council. Portland, Oregon: Prometheus Unbound Books, 1977.

This report was prepared for the residents of the state of Oregon to help them plan and decide their energy futures. Although addressed specifically to Oregon settings, much of the data presented is national in scope. The appendix on energy requirements of various energy systems illustrates the power of the energy delivery system concept.

PART TWO:
ENERGY CONSERVATION
RESOURCE BIBLIOGRAPHY

ENERGY CONSERVATION RESOURCE BIBLIOGRAPHY

1. PRINTED MATERIALS

Following is a list of printed materials relevant to developing a comprehensive understanding of energy conservation. In selecting references for this list an emphasis was placed on including materials that are readily available.

A. Reference Works: The following books contain elaborations of many of the concepts included in the Energy Conservation Curriculum Model.

Adelson, Philip H., ed. Energy Use: Conservation and Supply. Washington, D.C.: Association for the Advancement of Science, 1974.

Compilation of articles on energy supply and alternative systems.

Annual Review of Energy. Palo Alto, CA: Annual Reviews, Inc. Published annually beginning in 1976.

Compilation of essays reviewing the latest in energy - usually rather technical but includes other relevant reviews.

Clark, Wilson. Energy for Survival. Garden City, New York: Anchor Books, 1974.

A valuable discussion of the impacts of energy technology on the environment.

Commoner, Barry. The Poverty of Power: Energy and Economic Crisis. New York: Knopf, 1976.

Elaborate discussion of some of the economic issues.

Cornish, Edward. The Study of the Future: An Introduction to the Art and Science of Understanding and Sharing Tomorrow's World. Washington, D.C.: World Future Society, 1977.

Readable introduction to the study of the future - excellent bibliography.

Ehrlich, Paul R., Ehrlich, Anne H., and Holdren, John P. Ecoscience: Population, Resources, Environment. San Francisco, CA: W.H. Freeman and Company, 1977.

A compendium of information on topics related to energy and environmental topics.

Foin, Theodore C., Jr. Ecological Systems and the Environment. Boston: Houghton Mifflin Company, 1976.

Presents a unified framework for environmental analysis.

Ford Foundation. A Time to Choose: America's Energy Future. New York: Ballinger, 1974.

A classic volume - focuses on the energy future.

Fowler, John. Energy-Environment Sourcebook (Volumes I & II). Washington, D.C.: National Science Teachers Association, 1975.

A wealth of energy information and data.

Future Strategies for Energy Development: A Question of Scale. Oak Ridge, TN: Oak Ridge Associated Universities, 1977.

A compilation of excellent and relevant readings.

Grossman, Richard and Daneker, Gail. Jobs and Energy. Washington, D.C.: Environmentalists for Full Employment, 1977.

Analyzes the relationship between jobs and energy with a focus on conservation and renewable resources.

Lovins, Amory. Soft Energy Paths: Toward A More Durable Peace. San Francisco: Friends of the Earth, 1977.

Presents the concepts of "hard" and "soft" energy paths.

Merrill, Richard and Gage, Thomas, eds. Energy Primer: Solar, Water, Wind, and Biofuels. New York: Delta Books, 1978.

A review and compilation of resources for small scale energy systems.

Nash, Hugh, ed. Progress As If Survival Mattered: A Handbook for a Conserver Society. San Francisco: Friends of the Earth, 1977.

Application of conservation conscience to many fields of activity.

Odum, Howard and Odum, Elizabeth. Energy Basis for Man and Nature. New York: McGraw Hill, 1976.

Discussion of net energy systems and energy diagramming.

Schumacher, E.F. Small is Beautiful: Economics as if People Mattered. New York: Harper and Row, 1973.

Contains the theory and practice of intermediate technology.

Steinhart, Carol E. and Steinhart, John. Energy: Sources, Uses and Role in Human Affairs. North Scituate, MA: Duxbury Press, 1974.

Broad introduction to energy concepts and resources.

B. Periodicals: Articles on energy conservation can be found in the professional and trade periodicals associated with most occupational areas. Following is a list of periodicals that have a major emphasis on energy and environmental issues. Introductory review copies will usually be sent on request.

Catalyst for Environmental Quality. 274 Madison Avenue, New York, NY 10016.

Conservation Foundation Newsletter. 1717 Massachusetts Avenue, N.W., Washington, D.C. 20036.

Conservation News. National Wildlife Federation. 1412 16th Street, N.W., Washington, D.C. 20036.

Ekistics. Athens Center for Ekistics. 24 Strat Syndesmou, Athens, 36, Greece.

Energy and Environment Newsletter. National Science Teachers Association. 1742 Connecticut Avenue, N.W., Washington, D.C. 20009.

Energy and Power. National Educational Council on Energy and Power. P.O. Box 618, Concord, MA 01742.

Energy Insider. U.S. Department of Energy. Mail Stop 8G031, Washington, D.C. 20585.

Environment. Scientist's Institute for Public Information. 560 Trinity Avenue, St. Louis, MO 63130.

Environment News Digest. 250 Park Avenue, New York, NY 10017.

Environmental Action. Room 731, 1346 Connecticut Avenue, N.W., Washington, D.C. 20036.

Environmental Action Bulletin. 33 East Minor Street, Emmaus, PA 18449.

Environmental Education Report. 1621 Connecticut Avenue, N.W., Washington, D.C. 20009.

Environmental Report. Trends Publishing Company. National Press Building, Washington, D.C. 20004.

Environmental Reporter. Bureau of National Affairs, Inc. 1231 25th Street, N.W., Washington, D.C. 20037.

Environmental Science and Technology. American Chemical Society, 1155 16th Street, N.W., Washington, D.C. 20036.

Journal of Energy. American Institute of Aeronautics and Astronautics. 1290 Avenue of the Americas, New York, NY 10019.

Journal of Energy Education. Energy Information Associates, Inc. P.O. Box 18076, Capital Hill Station, Denver, CO 80218.

Journal of Environmental Education. Heldref Publications. 400 Albermarle Street, N.W., Washington, D.C. 20016.

Journal of Environmental Health. National Environmental Health Association. 1600 Pennsylvania Street, Denver, CO 80203.

Journal of Environmental Management. Academic Press. 111 Fifth Avenue, New York, NY 10003.

Journal of Environmental Quality. 677 South Segoe Road, Madison, WI 53711.

People and Energy. Institute for Ecological Policies. 1413 K Street, N.W., Washington, D.C. 20005.

Rain: Journal of Appropriate Technology. 2270 N.W. Irving, Portland, OR 97210.

Resources. Resources for the Future. 1755 Massachusetts Avenue, N.W., Washington, D.C. 20036.

C. Career Related Materials: Following is a list of books and pamphlets dealing with environmental and energy careers. Most of those produced by the government or trade associations are free; those from commercial publishers are not. Refer to the references at the end of the Human Systems Needs and Energy: Jobs and Conservation discussion in Part One for additional references on energy and job impacts.

Career Challenges in the Natural Gas Energy Industry. American Gas Association. 1515 Wilson Boulevard, Arlington, VA 22209.

Career Choices: Working Toward a Better Environment. U.S. Environmental Protection Agency. Attn: Personnel Management Division, Washington, D.C. 20460.

Career Opportunities in the Environmental Protection Agency. U.S. Environmental Protection Agency. Attn: Personnel Management Division, Washington, D.C. 20460.

Career Opportunities in the Scrap Metal Industry. Institute of Scrap Iron and Steel. 1729 H Street, N.W., Washington, D.C. 20006.

Career Profiles in Forestry, Conservation, Ecology, and Environmental Management. American Forest Institute. 1619 Massachusetts Avenue, N.W., Washington, D.C. 20036.

Careers in Environmental Protection by Reed Millard. Published by Messner, a Division of Simon and Schuster, New York.

Careers in Meeting the Energy Crisis. Federal Power Commission. 825 North Capitol Street, N.E., Washington, D.C. 20426.

Conservation Careers. National Wildlife Federation. 1412 16th Street, N.W., Washington, D.C. 20036.

Ecology and Your Career. U.S. Department of Labor, Bureau of Labor Statistics. Occupational Outlook Service, GAO Building, Washington, D.C. 20212.

Environmental Careers by James and Lynn Hahn. Published by Franklin Watts, Inc.

Guide to Conservation Careers. National Association of Conservation Districts. 408 East Main, League City, TX 77573.

Is There a Career in the Electric Industry for You? (A film) Distributed by Counselor Films, Inc.

Is there a Career in Mining, Petroleum, or Gas Production for You? (A film) Distributed by Counselor Films, Inc.

Jobs in the Environment. Published by Science Research Associates, Chicago.

Working Towards a Better Environment: Career Choices. U.S. Government Printing Office, Washington, D.C. 20402.

Your Career in Ecology. Ecological Society of America, Department of Biology. Rutgers University, Camden, NJ 08102.

II. FILMS

Following is a list of selected titles of films dealing with energy and environmental topics. All are appropriate for senior high to adult level. The film distributor is also provided. You should, however, check first with your institution's audio-visual department or the closest university film library. It is often easier and less expensive to obtain the films from them than from the distributor. The U.S. Department of Energy Technical Information Center also offers over 200 films on a free loan basis. Request the Energy Film Catalog from the Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

A Question of Balance. Edison Electric Institution.

Presents the complexities created by increased energy demands.

A Thousand Suns. Barr Films.

Deals with the need for more environmentally-oriented life styles.

Bill Loosely's Heat Pump. National Film Board of Canada.

Demonstrates setting up a heat pump.

Challenge of the Future. Department of Energy.

Deals with energy options for future.

Choices. Counselor Films, Inc.

Choice between balanced growth and environmental responsibility.

Desert Cloud. Airworks.

Explores solar energy.

Energy Crisis. Journal Films.

Explores depletion of fossil fuels and options.

Energy Series. Churchill Films.

A series of excellent films on energy issues.

Geothermal Power. AV-ED Films.

Explains geothermal power.

Laws of Conservation of Energy and Matter. Coronet.

Explains First Law of Thermodynamics.

LNG Is On Its Way. Modern Talking Picture Service.

Shows how LNG is brought to U.S.

Natural Gas Fuel Cell. Brooklyn Union Gas.

Traces development of natural gas fuel cell.

Now that the Dinosaurs Are Gone. Atomic Industrial Forum.

Addresses need for nuclear power.

Nuclear Dilemma. Time-Life.

Examines both sides of nuclear issue.

The Other Way. Time-Life.

Presents views of E.F. Schumacher.

Solar Frontier. Mellenco Film.

Explores solar power.

Toast. Earth Chronicle Production.

Explores net energy required to produce a piece of toast.

Understanding Matter and Energy. International Film Bureau.

Outlines forms of matter and energy.

III. USEFUL INFORMATION RESOURCES

The following organizations are good resources for keeping up energy and environmentally related activities. Many of them act as a clearinghouse as they collect, index, and abstract materials produced by the thousands of educational and other research and development institutions involved in energy and environmental activities. Write each to see what services are provided and what publications are produced.

Energy and Education Action Center, United States Office of Education. Suite 514, Reporter's Building, 300 Seventh Street, S.W., Washington, D.C. 20202.

Coordinates all energy-related education activities among Federal agencies; serves as a clearinghouse on energy and education activities.

Energy and Man's Environment, Inc. 0224 S.W. Hamilton, Portland, OR 97201.

Initiates and supports balanced programs designed to create an energy literate public; compiles bibliographies, resource lists.

Engineering Index, Inc. 345 East 47th Street, New York, NY 10017.

Abstracts and indexes materials related mainly to engineering but also reviews Department of Energy and National Technical Information Service materials.

Environmental Information Center, Inc. 292 Madison Avenue, New York, NY 10017.

Clearinghouse for energy and environmental information. Publishes an index and abstract series in both areas.

Environmental Protection Agency, Office of Research and Development, Energy, Mineral, and Industry. 401 M Street, S.W., Washington, D.C. 20460.

As part of its mission to inform the public, the EPA produces and distributes many free materials.

ERIC Clearinghouse on Adult, Career, and Vocational Education. National Center for Research in Vocational Education. 1960 Kenny Road, Columbus, OH 43210.

Collects and prepares abstracts of materials related to adult, career, and vocational education.

ERIC Clearinghouse on Science, Mathematics, and Environmental Education. Ohio State University, 1200 Chambers Road, Columbus, OH 43212.

Collects and prepares abstracts of materials related to science, math, and environmental education.

National Science Teachers Association. 1742 Connecticut Avenue, N.W., Washington, D.C. 20009.

Actively involved in publishing energy-related instructional materials and bibliographies.

Rain. 2270 N.W. Irving, Portland, OR 97210.

A non-profit organization concerned with appropriate technology, local self-reliance, and related issues.

U.S. Department of Energy, Technical Information Center. P.O. Box 62, Oak Ridge, TN 37830.

Collects, indexes, abstracts, and distributes energy related materials. Also publishes and distributes free information booklets including many that deal with ways to save energy.

U.S. National Technical Information. 5825 Port Royal Road, Springfield, IL 22161.

Collects, indexes, abstracts, and distributes materials obtained mainly from U.S. government files, on all technical areas including topics related to energy and the environment.

IV. MISCELLANEOUS RESOURCES

The following references actually belong in the previous categories. Because, however, these periodicals do not typically deal with energy or environmental issues, they are worth mentioning in this special category.

Library Journal. R.R. Bowker Co. 1180 Avenue of the Americas, New York, NY 10036.

> *The entire January 1 issues of this journal in 1977, 1978, and 1979 were devoted to publishing extensive resource lists of energy materials. Although designed to help librarians in reference work, collection building, and curriculum, the lists are invaluable to others as well. Each contains over several hundred sources of print and non-print information. They are particularly useful in accessing materials produced by organizations and industries such as utilities and trade associations. These are perhaps the most comprehensive listings of materials that are relatively readily available. A MUST FOR ANYONE SERIOUSLY INTERESTED IN THE TOPIC.*

Voc Ed, Journal of the American Vocational Association. American Vocational Association, Inc. 2020 N. 14th Street, Arlington, VA 22201.

> *The entire January, 1979 issue of this periodical was devoted to energy, including articles on energy conservation. They are particularly relevant because they focus on the needs and concerns of vocational educators. The February, 1979 issue contains an energy resource list.*

APPLICATION
GUIDE

THE
ENERGY
CONSERVATION
CURRICULUM
MODEL

APPLICATION GUIDE

INTRODUCTION

The purpose of this document is to illustrate how the approach to energy conservation developed in the previous three documents can be applied to the instructional process. The two basic ways described are through infusion into existing courses in the curriculum and through the development of new courses on energy conservation-related topics. A section of the Guide has been devoted to each of these two application methods.

In Section One, general guidelines for the infusion process are provided. Two examples of infusion into existing courses are also given. The first is infusion into an "Introduction to Auto Mechanics" course; the second is an "Introduction to Solar Energy" course.

Section Two deals with perhaps the easier of the two ways to apply a comprehensive understanding of energy conservation to instruction. New courses or units of study can be developed around energy conservation topics. Two examples are provided. The first is a course on energy conservation itself and the second is a career exploration unit.

Whether one is infusing energy conservation concepts and principles into existing courses or developing new courses based on these concepts and principles, educators should keep several general guidelines in mind. The overall purpose for teaching energy conservation is to help students to understand the following:

1. There are a great number and variety of ways in which we can learn to do better with our energy resources. In almost all our energy-producing and utilizing technologies, improvements can be made so that we can use energy efficiently, effectively, and appropriately. Indeed, even if we did not have a fossil fuel crisis, it would still be worthwhile to conserve energy.

2. To determine whether we are doing better with our energy resources, we must examine energy technologies as well as the relationships between energy and the environmental quality and between energy and the equitable satisfaction of human needs. The need to conserve energy provides us with an opportunity to improve quality in both of these areas.

3. Energy conservation has important implications for workers in all occupational fields. To deal effectively with our nation's energy problems we will undoubtedly need workers in new energy fields and persons with skills in energy conservation technology in energy-related fields. But, we will also need workers who know how to use energy appropriately in whatever fields they might be.

4. Implementing effective energy conservation programs and strategies will require us to shift our priorities and examine our values. Further, we will have to analyze and make decisions with respect to many complex situations and relationships both in our personal lives and on the job. In doing so, we should try to be as comprehensive as possible in the knowledge we bring to the problem-solving process.

The goal, then, of the educator is to develop or utilize materials and instructional activities which contribute to the development of these comprehensive knowledge and decision-making skills.

SECTION ONE:

INFUSING ENERGY CONSERVATION CONTENT INTO EXISTING COURSES IN THE CURRICULUM

INFUSING ENERGY CONSERVATION INTO EXISTING COURSES IN THE CURRICULUM

General Infusion Strategies

The term "infusion" or integration, as it is sometimes called, refers to the process of weaving energy conservation content into existing instructional activities. The rationale for infusion is based on the premise that most instructional programs are already overburdened; thus, existing instructional objectives and activities must be used as a basis for incorporating energy conservation content. As a result, two seemingly disparate curriculum goals can be met simultaneously. In other words, students will learn about energy conservation while accomplishing the objectives set for them in the existing instructional program.

Infusion requires instructors to engage in a constant cross-referencing process, continually moving back and forth between the subject matter and activities of the existing curriculum and the content domains of energy conservation. Thus, the instructor must start with competencies in the following areas:

1. Knowledge of the subject matter of the existing curriculum.
2. Knowledge of energy conservation and the elements important to this understanding as described, for instance, in the Curriculum Content Model.
3. Skills in developing, implementing, and evaluating instructional techniques and materials at the classroom level.

In addition, it is also important that the instructor have a positive attitude towards approaching infusion tasks and helping students to understand energy conservation.

There are a variety of ways that infusion can be carried out. One of these is simply to make continual references to energy in all that is taught. This is apt, however, to be rather unsystematic and disorganized. The following techniques are more systematic. Each technique is illustrated using an example of a typical objective from an auto mechanics course.

1. Adding energy content to the activities used to support current objectives.

   Current Objective: Students will learn the major systems and their functions in an automobile.

   Added Content: *Ensure that students understand the efficiency of these systems; how more efficient systems could be developed; impact of pollution on environment; pros and cons of diesel mechanics.*

2. Enriching or expanding current objectives and related instructional activities to include an energy component.

   Current Objective: Students will learn the proper care and hanling of tools.

   New Objective: *Students will learn the proper care and handling of tools including ways to use them in an energy-efficient manner.*

3. Rewriting current objectives so that they have an energy conservation focus.

   Current Objective: Students will write a 1000 word term paper on an automotive topic.

   New Objective: *Students will write a 1000 word term paper on automobiles and their relationship to an energy conservation or environmental quality topic.*

4. Adding new energy conservation focused objectives and activities.

   Current Objective: None

   New Objective: *Students will understand how future career opportunities in the automobile repair industry might be affected by fuel shortages and the national need to conserve energy.*

5. Using energy conservation as the context in which all instructional activities take place.

   This would be difficult to do in most vocational courses. It could be applied, however in adult basic education courses such as remedial mathematics. In this example, students could learn basic math skills while doing energy audits, computing utility bills, surveying attitudes towards energy conservation, etc.

Infusion Guidelines

The following guidelines are suggested as a way of approaching the task of infusing energy conservation content into existing instructional programs.

1. List current objectives and major instructional activities as well as the instructional resources used by students.
2. Based on an understanding of the overall purposes for teaching energy conservation and the Content Model and Resource Book, identify ways to give an energy conservation focus to these objectives, activities, or materials. To aid this process, cross-reference each aspect of the current instructional program to the elements in each of the six sectors in the Curriculum Content Model. Determine which aspects of the program are already closely related to the concepts in the Content Model. Using the infusion strategies outlined above, identify ways to modify or to add to current instructional objectives, activities or materials so that they by design address those elements in the Curriculum Content Model to which they are most closely related. Optimally, concepts in each sector of the Content Model should be covered at least once during the course. It may be necessary to add new content to the course in order to do so. The overall goal is to be as comprehensive as possible and to operationalize or translate the concepts and relationships in the Content Model into terms which are meaningful in view of the subject being taught.
3. Using the references and information resources presented in the Resource Book, obtain or develop instructional materials and activities to support the revised program. In some cases, appropriate materials are readily available. In other instances, new materials may need to be developed or existing materials adapted to meet the needs of students.
4. Finally, implement the revised course using sound and effective instructional techniques.

This is a complex task, but it can be done. Following are two examples to illustrate the process.

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EXAMPLE ONE

Infusion Into A Technical Subject In An Energy-Related Field

A Course Title

Introduction to Diesel Mechanics*

B. Course Description

Students in this course will study the principles of the various automotive systems and units within these systems. They will become familiar with tools and procedures for repair, diagnostic work and trouble-shooting procedures for electrical and mechanical problems. The automotive industry and its relationship to the economic society will also be examined.

C. Existing Course Objectives

The student will:

Objective 1. Understand how to use automotive testing equipment and diagnostic units on parts such as generators and alternators and be able to complete detailed check sheets showing parts, defects and procedures.

Objective 2. Be able to complete a comprehensive safety test dealing with shop practices and hazards.

Objective 3. Be able to keep a detailed lab notebook with progress sheets outlining their activity and progress on lab projects.

Objective 4. Be able to keep a detailed notebook covering the relationship between classroom theory and the units to be torn down in shop work.

Objective 5. Write a term paper of no less than 1000 words covering some area pertaining to the automobile industry.

Objective 6. Learn the proper care and handling of hand tools.

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*Adapted from a course outline developed at San Jose City College, San Jose, California.

D. Infusion Strategies

There are a number of potential areas where energy conservation could be infused into this course. In the classroom lectures, for example, topics related to the environmental effects of automobiles, the implications of our continuing gasoline crisis on the auto repair industry, and projected futures for the automobile and auto repair industries could be introduced. Additional possible topics include current and changing American values regarding the automobile and transportation, the role the automobile repair industry can play in helping Americans conserve gasoline, alternative automobile designs, and specific strategies that could be implemented on the job to conserve energy resources. It would be difficult, considering the regular content that must be covered, for these discussions to be lengthy. The goal is, however, to introduce students to these concepts. With respect to the existing objectives, the following additional infusion suggestions can be made:

Objective 1. Understand how to use automotive testing equipment and diagnostic units on parts such as generators and alternators and be able to complete detailed check sheets showing parts, defects, and procedures.

Infusion Strategy: Add content to ensure that students are able to detect defects which affect automobile efficiency and assess when repairs should be made to improve overall efficiency of the automobile.

Objective 2. Be able to complete a comprehensive safety test dealing with shop practices and hazards.

Infusion Strategy: Expand the objective so that it and related activities have an energy conservation component. Students should examine how shop hazards affect their health or environmental quality and understand how to implement practices which avoid these hazards. The new objective might be: students will be able to complete a comprehensive shop safety test specifying ways to implement effective ship practices and identifying how potential hazards might affect students' health and environmental quality.

Objective 3. Be able to keep a detailed lab notebook with progress sheets outlining their activity and progress on lab projects.

Infusion Strategy: Add content so that students consider how efficiently and effectively they are using lab resources to complete activities.

Objective 4. Be able to keep a detailed notebook covering the relationship between classroom theory on automotive systems and the units to be torn down in shop work.

Infusion Strategy: Add content to classroom lectures and add specification to notebooks so that students systematically address issues such as the design of the shop unit, how each system contributes to overall efficiency, potential alternative systems such as diesel, or gasohol fuel engines.

Objective 5. Students will write a term paper of no less than 1000 words covering some area pertaining to the automobile industry.

Infusion Strategy: Rewrite the objective to have an energy focus. New objective is: student will write a term paper on a topic analyzing the relationship between the automobile and an environmental or energy conservation topic.

Objective 6. Students will learn the proper care and handling of hand tools,

Infusion Strategy: Expand the objective to include an energy conservation component. New objective might be: student will learn the proper care and handling of hand tools and how to use them in an energy-efficient but productive manner.

E. Resources to be Used to Develop and Implement Revised Curriculum

Instructors would ensure that they understood concepts to be taught using references in Part One of the Resource Book. It is unnecessary to use an additional text, although it might be worthwhile to examine newly published texts to see if they contain more information on the relationship between energy and automobile design.

Part Two of the Resource Guide can be used to select additional resources for obtaining student materials. For example, using a United States Department of Energy publications list, obtain copies of relevant publications such as "Fuel Tips for Motorists." Contact automobile manufacturers or petroleum manufacturers, many of whose addresses and available materials are in the January 1 issues of Library Journal. Many of these have films available for free or low cost rental or provide informative brochures or pamphlets. The Society of Automotive Engineers may be particularly worthwhile to contact.

EXAMPLE TWO

Infusion Into A Technical Course In An Energy Field

A. Course Title

Introduction to Solar Energy

B. Course Description

The course is designed to provide post-secondary adult and technical students with a basic understanding of solar energy systems. It is not designed to provide technical skills for solar energy installation or maintainance.

C. Existing Course Objectives

Objective 1: Students will be able to explain why solar energy technology has developed and describe the characteristics of solar energy.

Objective 2. Students will be able to explain importance of sun's position in relation to the earth for making use of the sun's energy.

Objective 3. Students will be able to name the component parts of solar energy systems and specify the functions of each, i.e. collection, storage, distribution.

Objective 4. Students will be able to describe representative solar energy systems and identify advantages and disadvantages of each.

D. Infusion Strategies

Because the subject matter of this course is energy, it is relatively easy to infuse energy conservation concepts into it by expanding the content under each objective. In so doing, it is important to bring in concepts and principles from all six sectors of the Curriculum Content Model. Following are some of the ways the content can be expanded:

Objective 1. Students will be able to explain why solar energy technology has developed and describe the characteristics of solar energy.

Add content related to:

- *General nature of energy flows*
- *The nature of renewable and non-renewable resources*
- *Relationship of solar energy to other energy resources*
- *Why the development of solar energy has the potential to be a conservation measure*
- *Possible future and values associated with solar energy*

Objective 2. Students will be able to explain importance of sun's position in relation to the earth for making use of the sun's energy.

- *Discuss concept of energy quality*

Objective 3. Students will be able to name the component parts of solar energy systems and specify the function of each i.e. collection, storage, distribution.

- *Expand notion of solar energy system to the larger framework of energy delivery system*
- *Discuss possible environmental consequences at each stage in system*

Objective 4. Students will be able to describe representative solar energy systems and identify advantages and disadvantages of each.

- *Discuss technologies associated with each representative system using delivery system framework*
- *In identifying advantages and disadvantages of each system, use concepts of efficiency, net energy, scale, energy quality, and environmental impacts*
- *Discuss from a standpoint of conservation, inappropriate uses of solar energy*

Possible Added Objective: Students will be able to identify possible careers in solar energy field and analyze how the development of solar energy might affect other career opportunities.

E. Resources to be Used

Using Part One of the Resource Book will help instructors to understand any of the concepts with which they are not familiar. No new text for the class will be needed. In addition to the references contained in Part Two of the Resource Book, the following information resources listed in the January 1979 issue of VocEd may also be helpful in identifying additional student materials.

The National Solar Heating and Cooling Information Center
P.O. Box 1607, Rockville, Maryland 20850
(toll-free phone: 800-523-2829).

Solar Energy Research Institute, 1536 Cole Boulevard,
Golden, Colorado 80401.

SECTION TWO:

DEVELOPING INDEPENDENT COURSES BASED ON ENERGY CONSERVATION TOPICS

DEVELOPING INDEPENDENT COURSES BASED ON ENERGY CONSERVATION TOPICS

Independent units or courses of study may also be developed based on energy conservation topics. Indeed, this is already being done in many instances by a wide variety of organizations including: educational institutions, environmentally-related organizations, governmental agencies, public service groups, and utilities. Frequently, however, the scope of these courses is fairly narrow. They often focus on development of knowledge and skills in specific areas such as techniques to reduce the energy consumption in homes, school buildings, etc., or lifestyle changes that reduce energy consumption. As important as these topics are, it is suggested that these courses should also deal with the broader issues and concepts of energy conservation such as those presented in all six sections of the Content Model and Resource Book. In other words, even though a particular aspect of energy conservation is being covered or being dealt with in a specific context, this specificity should be related by design to the larger issues of the wise use of energy resources. Following are a few examples of the courses that might be developed:

- Energy conservation could be a "core" course for all students entering any occupational field. In this instance, content would not necessarily have to be infused into another course in the student's program of study. It is suggested that separate courses should be developed for the same or similar occupational fields (e.g., home economic, agriculture) so that the content and activities could be developed on a shared frame of reference. Emphasis would be placed on developing an awareness of how energy use and conservation relates to the field. Topics that might be discussed include how energy use in the particular field relates to the national use of energy, how current energy policies impact factors associated with their jobs such as typical technologies, practices and worker health, potential areas where better use of energy resources might be made, barriers to and benefits from implementing better energy use, and possible impacts of energy conservation on jobs.

- Energy conservation could also be the basis for courses for the further education of persons already working in existing occupations. Many of the same topics described in the previous example would be covered in this proposed course.

- The broader issues of energy conservation could be the basis for persons desiring to specialize in energy conservation in a particular occupational field. Presumably, additional courses in the curriculum for these energy conservation specialists would deal with specific techniques to assess and to better use energy. This course suggested here would deal with the larger issues of energy conservation as they relate to our national problem to better use energy.

- Energy conservation can be developed as a separate course for adult learners. Indeed, this is already being done in many instances. Using the framework of this Curriculum Model, the emphasis would be placed on providing students with a background and skills so that they can make appropriate decisions with respect to energy use in their own lives and are able to participate in informed decision-making about future energy policies.

- Energy conservation could be used as a basis for developing a unit or course in career guidance. The focus would be on developing students' understanding of possible energy-related careers and knowledge of how energy conservation might affect future careers and lifestyles. This would be particularly relevant in geographical regions where energy policies might have significant impact. It could be valuable in recruiting students to these careers and could also be extended to the secondary level.

These last two examples are illustrated in the sample course outlines which follow.

EXAMPLE THREE

An Energy Literacy Course for the Adult Learner

A. Course Title

Energy Conservation and the Quality of Life

B. Course Description

In this course, students will become familiar with the general nature of this nation's energy problem. A particular emphasis will be placed on those concepts and principles relevant to selecting appropriate energy strategies for the future and the relationship of those strategies to an improved quality of life. Students will be expected to assess their own lifestyles with respect to energy use; on the basis of this assessment, individual conservation strategies will be developed.

C. Course Objectives

This course should enable students to:

1. Understand the different facets of and need for energy conservation (i.e., a technical solution, a strategy for the future, an "ethic").
2. Understand the primary laws which govern natural system functioning and basic energy laws.
3. Become familiar with the general characteristics of our available energy resources.
4. Become familiar with a framework for examining the steps and/or processes involved in delivering energy resources.
5. Understand how and where energy utilization concepts can be applied in proposing or assessing energy conserving measures.
6. Become aware of the manner in which current and projected energy utilization practices affect the natural environment.
7. Become aware of the relationships between energy use and human need satisfaction (e.g., jobs, health, lifestyles).
8. Develop strategies that can be implemented at the individual level to better use energy.

D. Content Areas to be Covered

1. The energy dilemma: its nature and complexity.
2. An energy conservation ethic: preservation of environmental quality and equitable satisfaction of human needs.
3. Energy projections for the future.
4. Nature of our energy resources.
5. Laws of Thermodynamics.
6. Impact of energy use on ecosystems.
7. Energy utilization concepts.
8. Energy delivery systems.
9. Relationships between energy and human need satisfaction: job quantity and quality, health, lifestyles.
10. Techniques for lifestyle assessment of energy use.

E. Possible Activities

In addition to readings and discussions, one or both of the following activities might be useful as an ongoing or culminating project activity.

1. Present students with a problematic situation which requires them to make decisions about effective energy conservation measures. Example: the school district has to cut energy use by 35% or the community must reduce electricity usage by 35%. What type of energy conservation plan should be implemented? In developing the plan, consider the following:

   What energy resources are most affected?

   What impact will the plan have on the environment?

   Will the projected measures result in net energy savings?

   Can end use be matched with energy quality and appropriate technology?

What are lifestyle and job implications of the plan?

Will the system be better or worse off?

What are barriers to and benefits from implementing the plan?

2. Adopt a currently available lifestyle index or develop a new one. One such index is *Lifestyle Index-77* by Anne Pierotti and Albert J. Fritsch. It is available from Citizens Energy Project, 1413 K Street, N.W., Washington, DC 20009 for $2.00.

    a. Have students calculate their personal and household index.

    b. Develop a composite profile based on group estimates.

    c. Determine the best areas for making greatest savings.

    d. Suggest ways people can be encouraged to change their wasteful energy habits; discuss benefits from and barriers to implementing changes.

    e. Have each individual develop a personal energy conservation plan.

F. Useful Resources for Teacher and/or Student

Ehrlich, P.R.; Ehrlich, A.H.: and Holdren, J.P. *Ecoscience: Population, Resources, and Environment*. San Francisco: W.H. Freeman and Company, 1977.

Fowler, J. *Energy-Environment Sourcebook*. Washington, DC: National Science Teachers Association, 1975.

Nash, H. *Progress as if Survival Mattered: A Handbook for a Conserver Society*. San Francisco: Friends of the Earth, 1977.

Steinhart, C.; and Steinhart, J. *Energy: Sources, Uses and Role in Human Affairs*. North Scituate, MA: Duxbury Press, 1974.

Department of Energy and Governmental Printing Office pamphlets would be helpful, as would the lifestyle assessment index.

EXAMPLE FOUR

A Career Exploration Course

A. Course Title

Energy and Career Opportunities

B. Course Description

In initial readings and classroom lectures students will examine how energy policies affect current and future career opportunities. Career opportunities in energy-related fields will be specified using an energy delivery system framework. In independent study, students will examine the potential of energy-related careers to contribute to energy conservation and environmental quality. Students will also assess the potential of these careers to be personally satisfying. Students' independent projects will be shared with the class.

C. Objectives

This course should enable students to:

1. Become aware of energy and environmentally related career opportunities.
2. Develop a systematic framework for assessing the potential of these opportunities to become personally satisfying careers which also contribute to energy conservation and environmental quality.
3. Understand how career opportunities are affected by energy policies, particularly policies related to energy conservation.

D. Content

1. Importance of studying energy and jobs; need for conservation and a conservation ethic.
2. Energy use and its relationship to environmental quality; potential for conservation.

3. Energy use and its relationship to human need satisfaction; potential for conservation.

4. Present and future energy resources.

5. Energy delivery systems.

6. Assessment factors for energy/environmentally related jobs.

E. Possible Activities

Following is a suggested sequence of activities:

1. Initially, students would spend time developing a basic understanding of the need for energy conservation; how energy use is related to environmental quality and the satisfaction of human needs; and the potential for conservation. This need not be lengthy; instructors can use their geographical region as an initial context for these discussions.

2. Students then examine current and future energy resources and the energy delivery system framework.

3. Develop an Energy Resource Delivery System Matrix for each renewable and nonrenewable energy resource including the various forms of these resources. (See the Resource Book for a description of this matrix.*) Once the delivery stages have been specified, identify the typical occupations and jobs involved in each of the delivery stages for all current and projected energy resources. For example, geologists, chemists, engineers, drillers, etc. would be required in the petroleum exploration stage.

4. After identifying the various occupations, students, working individually or in small groups, would do an in-depth analysis of one or more occupational categories. In this activity, students obtain more information about the occupation, assess the relationship of the occupation to energy and environmental issues, and evaluate the potential of the occupation to become a personally satisfying career. Following is a list of questions that should be answered in carrying out this analysis:

   - What does a person in this occupation typically do?

   - What special skills are necessary?

   - What training is required?

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*Section Six

- How transferable are the skills and training to other job areas?
- What career ladders typically exist for the occupation?
- In what geographical locations is the job typically found?
- What are typical salary levels?
- What are the positive features usually associated with the job (e.g., challenging, travel, etc.).
- What are the negative features usually associated with the job, particularly health and safety hazards?
- To what extent is the technology, associated with the job, energy- and labor-intensive?
- What do "experts" say about future job opportunities?
- To what extent does the occupation contribute to solving our energy and environmental problems?
- What energy or environmental policies could affect future job availability?
- How do the student's abilities and interests relate to the occupation as a potentially satisfying career?

In answering the above questions, students would use materials typically found in a Career Resource Center and other library reference materials. They might also contact utilities, trade organizations, governmental agencies, etc.

5. After students have completed their individual projects, the information should be shared with the entire group.

F. Useful Resources

The Resource Book contains a detailed discussion of the energy delivery system concept. Both Parts One and Two of the Source Book contain bibliographies of a wide variety of career-related materials. Part Two also contains a list of potential information sources.

In addition, the following materials would be helpful:

- Several basic reference texts on conventional and alternative energy technologies.
- Several basic reference texts on ecology and environmental problems.
- A current Occupational Outlook Handbook available from the U.S. Government Printing Office.
- A current Dictionary of Occupational Titles available from the U.S. Government Printing Office.